DEPARTMENT OF TRANSPORTATION

Unmanned Aircraft System Bridge Inspection Demonstration Project Phase II

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Collins Engineers, Inc.

June 2017

Research Project
Final Report 2017-18

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Unmanned Aircraft System Bridge Inspection Demonstration Project Phase II

FINAL REPORT

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EXECUTIVE SUMMARY

An Unmanned Aircraft System (UAS) is defined by the Federal Aviation Administration (FAA) as an aircraft operated without the possibility of direct human intervention from within the aircraft. Unmanned aircraft are familiarly referred to as drones, and the names can be used interchangeably. The UAS is controlled either autonomously or with the use of a remote control by a pilot from the ground. These UASs offer a wide range of imaging technologies which include photographic stills, video, and infrared sensors that can be viewed live and later processed to assist with inspections.

Bridge inspections often pose logistical challenges to efficiently and effectively inspect a wide variety of structure types; therefore, inspection by UAS is a solution that can be safe and cost-effective. The Minnesota Department of Transportation (MnDOT) and Collins Engineers have been researching the use of UASs as a tool for bridge inspections in a multi-phase project. This phase of the study research identified potential applications of UAS technology to aid in bridge inspections and is a continuation of a previous study by the MnDOT.

The previous Phase I Study involved using a UAS to inspect four unique bridges at various locations throughout Minnesota. This small research project, which was conducted over a period of two months in the summer of 2015, investigated the technology's effectiveness compared to other common inspection access methods.

This Phase II Study was built on Phase I findings and looked at additional Minnesota bridges including a large steel through arch, a steel high truss, a large corrugated steel culvert, and a movable steel truss. The UASs' performance was compared to industry standard hands-on inspections. Each method was evaluated by focusing on the differences in access methods, data collection, and the ability to be used as a tool for interim and special inspections. FAA rules were explored to determine how practical they were in regard to UAS bridge inspection applications.

Before UAS fieldwork began on any of the selected bridges, detailed investigation and safety plans were prepared for each structure. Site-specific plans addressed safety, potential hazards and how to mitigate them, current FAA rules, and inspection methods.

Several imaging devices were tested including still image, video, and infrared cameras. After the data collection was completed, data were processed through the computer software Pix4D and supplemented with other imaging software to generate 3-D models and maps.

Based on our observations in the field from the Phase I and Phase II study, the following conclusions were made:

- UASs can be used safely and effectively on large bridges in challenging conditions.
- UAS can be used in GPS deprived environments but piloting skills become more important.
- An UAS is more suitable as a tool for inspection of bridges with elements that are difficult to access.

- UASs cannot perform inspections independently and should be used as a tool for qualified and experienced bridge inspectors to view and assess bridge element conditions in accordance with the National Bridge Inspection Standard (NBIS).
- An UAS used in conjunction with thermal sensors can be an effective way to detect concrete delaminations and can be done without closing the bridge to traffic by flying adjacent to the traffic lanes.
- Measurements can be estimated from images, but tactile functions (e.g., cleaning, sounding, measuring, and testing) equivalent to a hands-on inspection cannot be replicated using an UAS.
- The ability to direct cameras 90 degrees upward and the ability to fly without a GPS signal are important features when using this technology as an inspection tool.
- UAS technology is evolving rapidly and inspection-specific UAS features are just coming into the marketplace that will increase their performance as it relates to bridge safety inspection.
- In some types of inspections, an UAS has the capabilities to be used in lieu of an under-bridge inspection vehicle and would provide significant savings. These savings would come in the form of reduced or eliminated traffic control and reduced use of under bridge inspection vehicles and lifts.
- UASs can provide a cost-effective way to collect detailed information that might not normally be obtained during routine inspections.
- Safety risks associated with traffic control, working at heights and near traffic could be reduced with the use of an UAS.
- Traffic control costs can be reduced with the use of an UAS in addition to the savings obtained through the reduced use of under bridge inspection vehicles and rope access.
- UASs can provide important pre-inspection information for planning large-scale and for emergency inspections. Information such as clearances, rope access anchor points and current and general conditions can easily be secured with an UAS to aid in the planning of an inspection.
- Utilizing an UAS in conjunction with photogrammetry software can provide a three dimensional model and point cloud of a bridge and bridge site that is valuable in determining unknown dimensions and provides a high-quality inspection report deliverable.

Based on the information presented in this report, the following recommendations are made:

- The use of an UAS to aid bridge inspection should be considered as a tool for a qualified Team Leader only when a hands-on inspection is not required.
- The use of UASs to aid bridge inspections should be considered for routine inspections to improve the quality of the inspection by collecting data that may not be readily obtained without expensive access methods.
- UASs should also be considered where increased safety for inspection personnel and the traveling public can be achieved without compromising inspection quality.
- As part of the Phase III Study, a collision tolerant UAS should be investigated for use in tight and confined spaces such as truss bridges and box girders.

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

An Unmanned Aircraft System (UAS) is defined by the FAA as an aircraft operated without the possibility of direct human intervention from within the aircraft. UASs are commonly referred to as drones and the names can be used interchangeably. The UAS is controlled either autonomously or with the use of a remote control by a pilot from the ground and can carry a wide range of imaging technologies including still, video, and infrared sensors. Inspection by UAS presents itself as a safe and cost-effective solution for bridge inspections as they often pose logistical challenges to access and assess all of a structure's elements. This study was intended to research the potential applications of UAS technology when applied to bridge inspections.

In the summer of 2015, a small Phase I study to evaluate the use of UASs for bridge inspections was performed, and the resulting study was published by MnDOT's Research Services. The Phase I Study involved using the Aeyron Skyranger, a quadcopter drone, to inspect four unique bridges at various locations throughout Minnesota with a comparative investigation of the technology's capabilities.

Based on the conclusions and recommendations of the first study, the overall goal of Phase II was to further evaluate the effectiveness of UASs when applied to bridge safety inspections. Phase II employed an inspection specific drone and looked at additional bridges throughout Minnesota including a large steel through arch, a steel high truss, and a large corrugated steel culvert.

Before UAS fieldwork began on any of the selected bridges, a detailed investigation and safety plan was prepared for each structure. Site-specific plans addressed safety, potential hazards and how to mitigate them, current FAA rules, and inspection methods. Several imaging devices were tested including still image, video, and infrared cameras. After data collection was complete, the data were processed through Pix4D and supplemented with other imaging software to generate 3-D model and maps.

For Phase II, the senseFly Albris, an inspection-specific UAS, was utilized to conduct the fieldwork. This report details this newer technology specific to inspection, includes a cost comparison to traditional access methods, and lists advantages and disadvantages of using the UAS during a hands-on bridge inspection. The second phase also included the development of a UAS best practices document based on the results of the study.

During this study, FAA rules changed significantly. The previous Section 333 exemptions were replaced with the new Part 107 Rules. The previous and current rules were investigated to determine how they relate to bridge safety inspection use. These findings are detailed in Chapter 2.

1.1.1 Bridges

The following bridges were selected for the study after extensive coordination and evaluation:

1. Bridge 9030, John A. Blatnik Bridge, Duluth, MN – Steel Through Arch with Multi-Girder Approach Spans
2. Bridge 5767, Nielsville, MN – Steel Truss
3. Bridge 62513, Saint Paul, MN – Corrugated Steel Culvert
4. Bridge 4654, Stillwater, MN – Steel Truss Movable Bridge

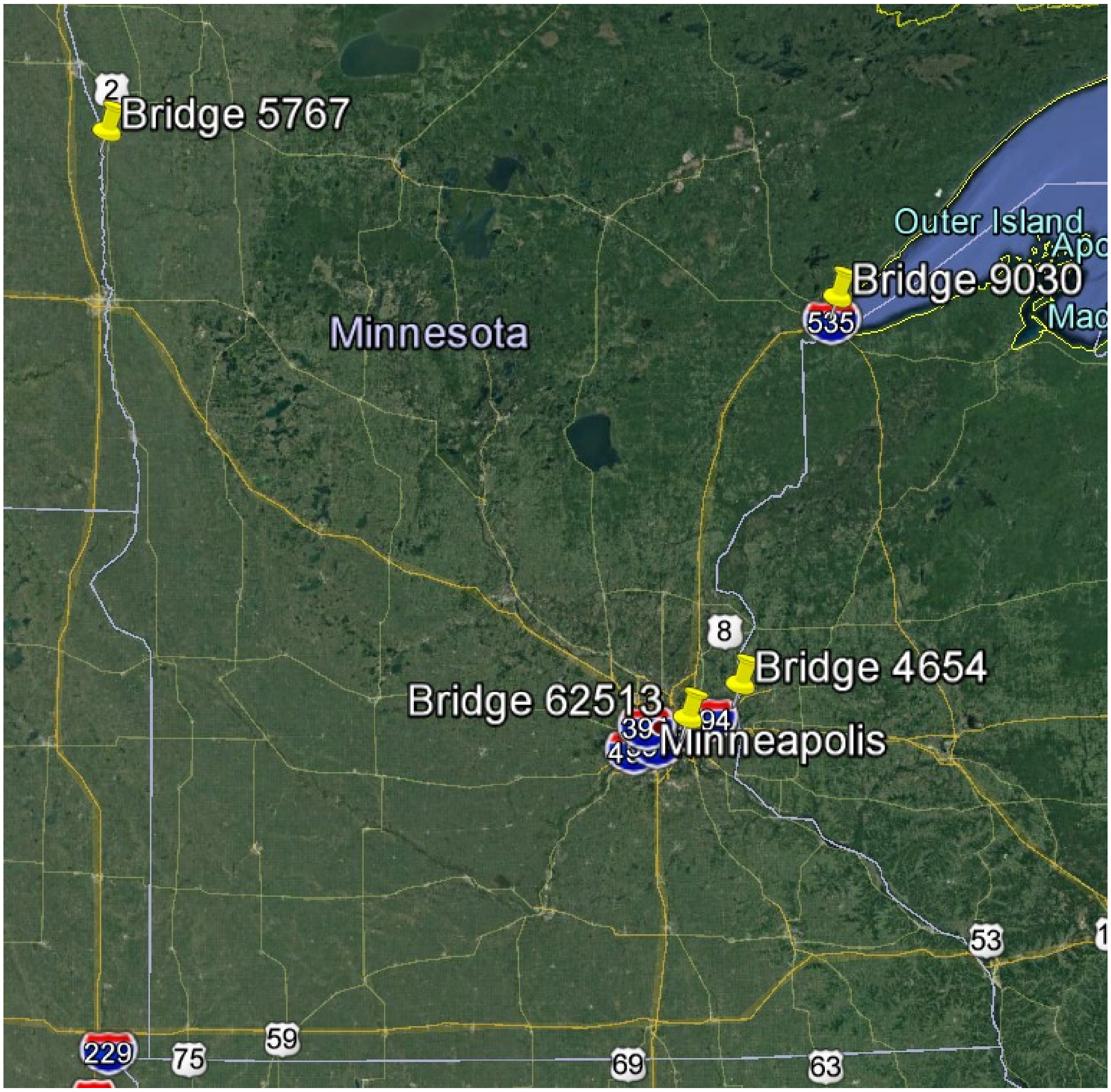

Figure 1-1 Overall Location Map of Phase II Bridges.

CHAPTER 2: FAA AND STATE REGULATIONS

2.1 FEDERAL AVIATION ADMINISTRATION (FAA) RULES

During this project, the FAA regulations changed significantly. The first half of the fieldwork portion of the project was performed under the previous rules and the last half was performed under the new, more flexible, Part 107 Rules.

2.2 PREVIOUS FEDERAL AVIATION ADMINISTRATION (FAA) RULES

2.2.1 Certificate of Authorization (COA)

In March 2015, the FAA granted a blanket COA for flights below 200 feet provided the aircraft was less than 55 pounds, operations were conducted during daytime -Visual Flight Rules (VFR) conditions, maintaining Visual Line of Sight (VLOS) of the pilot, and the required minimum distance away from airports or heliports. This blanket COA allows flying anywhere in the country except restricted airspace and other areas, such as major cities, where the FAA prohibits UAS operations. Blanket COAs are awarded to certain commercial operators who obtain Section 333 exemptions detailed below. A certificate of authorization is required if a UAS is operated outside of criteria for the blanket COA.

2.2.2 Section 333 Exemption

Prior to August 29th 2016, operation of a UAS for commercial purposes required an FAA "Section 333 Exemption". These exemptions were provided on a case by case basis and took several months to receive approval. Additional restrictions for UAS use were also defined including the requirement to employ a licensed private pilot for all flights. All work completed on UAS projects prior to the 2016 rule changes followed this process.

2.3 CURRENT FAA RULES

On August 29th 2016, the FAA issued new regulations regarding the commercial use of UASs. The new policies are referred to as Small Unmanned Aircraft Regulations (Part 107). These new regulations are intended to establish more general and basic guidelines for commercial entities. Part 107 significantly reduces the steps in the approval process, creating a more straightforward path to employing UASs in commercial applications. The new legal guidelines apply to drones weighing less than 55 pounds, operated within the visual line of sight of the remote pilot in command, and flown during daylight hours. The remote pilot in command must have a Remote Pilot Certification from the FAA, which can be obtained by passing an aeronautical knowledge test. With direct supervision from a licensed remote pilot, anyone over the age of 16 can legally operate a drone for commercial purposes. Each UAS must be registered with the FAA. Operations in Class G airspace are allowed without air traffic control permission; however, operations in Class B, C, D and E airspace need air traffic control (ATC) approval.

Part 107 was widely regarded as a big improvement in the path toward utilizing UAS technology for commercial operations. The majority of bridges and airports are near populated areas so most bridges fall outside of “G” airspace and require specific airspace authorizations. Receiving airspace authorizations in Class B, C, D and E airspace have been inconsistent, but generally takes 2-4 weeks to receive. Part 107 waivers are taking up to 90 days. These timelines fall outside of the typical planning window for bridge inspections. Any type of emergency inspection is all but ruled out, negating some of the benefits of utilizing UAS for bridge inspections. The FAA has committed to developing a software based application that would give instantaneous airspace authorizations, but this technology may not be in place until the fall of 2017.

More information on Part 107 can be found on the FAA website.
https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516

2.4 MNDOT REGULATIONS

2.4.1 MnDOT Aeronautics

Our team worked in close coordination with the MnDOT Office of Aeronautics to plan the project and attain the necessary approvals. The Aeronautics Office has an official policy for the use of UAS on MnDOT projects. UAS registration and proof of insurance are required. Before embarking on any commercial UAS use in Minnesota, pilots should first contact MnDOT’s Office of Aeronautics. The policy is detailed at the following website: http://www.dot.state.mn.us/policy/operations/op006.html

CHAPTER 3: ASSESSMENT OF CURRENT PRACTICES

3.1 BRIDGE INSPECTION ACCESS METHODS

Bridge inspections are performed using a range of methods to access areas of bridges that may be unreachable from the ground or bridge deck. Various methods work well in different conditions and with assorted bridge types. The following discussion details some of the traditional access methods and their advantages and disadvantages when utilized in bridge inspection.

3.1.1 Aerial Work Platforms (AWP)

AWP include an assortment of equipment commonly referred to as under bridge inspection vehicles, snoopers, lifts, or bucket-trucks. This equipment is the most prevalent method for accessing difficult to reach areas of a bridge. Several of the associated advantages and disadvantages are listed below.

AWP Advantages:

- Ability for inspector to be within arm's reach of bridge components,
- Availability,
- Reliability, and
- Versatility.

AWP Disadvantages:

- High capital and maintenance costs,
- Safety of inspector and public,
- Bridge weight restrictions,
- May require lane closures,
- Mobilization time and cost, and
- Qualified operator required (typically additional staff member on site).

Figure 3-1 Example of an Under Bridge Inspection Vehicle

3.1.2 Rope Access

Rope access is another prevalent form of access used in bridge inspections. This method involves specially trained and certified rope access professionals using ropes and climbing equipment to observe portions of the bridge which are unreachable from the ground or bridge deck.

Advantages:

- Ability for inspectors to be within arm’s reach of bridge components,
- Low equipment costs, and
- Lane closures typically are not required.

Disadvantages:

- Availability,
- Mobilization costs, and
- Training requirements.

Figure 3-2 Example of a Rope Access Inspection.

3.2 EVALUATION OF NATIONAL BRIDGE INSPECTION STANDARD (NBIS) AND MNDOT STANDARDS

The minimum standards for bridge inspections are defined by the NBIS and are further detailed by the MnDOT Bridge and Structure Inspection Program Manual for bridges within Minnesota. The NBIS defines several different types of inspections including initial, routine, in-depth, fracture critical, complex, damage, special and underwater.

The minimum level of detail required varies according to the structure's type, size, design complexity, existing conditions and location. Some bridge elements, including fracture critical members, require a hands-on inspection as specified by the NBIS, which is not possible with the use of UASs. A list of these elements are included in the MnDOT Bridge and Structure Inspection Program Manual as part of Section A.5.2 and can be viewed here http://www.dot.state.mn.us/bridge/inspection.html.

For structural members not requiring a hands-on inspection, a UAS can be used as a tool (not a replacement) to assist an inspector in gathering more in depth information than would normally be collected. An example would be the ability to observe the conditions at the bearings or connections that may normally only be observed from some distance greater than arm's length.

Figure 3-3 Example of the Detail Obtained in a Difficult to Access Location.

This project adhered to the following standards and guidelines:

- "Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges" Federal Highway Administration (FHWA) Report No. FHWA-PD-96-001 (1995), including 2003/2004 errata.
- Bridge Inspector's Reference Manual (BIRM), dated February 2012, FHWA National Highway Institute (NHI) 12-049
- Code of Federal Regulations, 23 CFR Part 650, Subpart C, National Bridge Inspection Standards.
- "MnDOT Bridge and Structure Inspection Program Manual" 2016.

For this reason they are able to cover longer distances, map much larger areas, and loiter for long times monitoring their point of interest. In addition to the greater efficiency, it is also possible to use gas engines as their power source, and with the greater energy density of fuel many fixed-wing UAVs can stay aloft for 16 hours or more.

CHAPTER 4: ASSESSMENT OF UAS TECHNOLOGY

UAS technology has been around for many years, but has advanced rapidly as it has become affordable and more widely available for commercial and hobby use. Another factor contributing to the swift acceleration of civilian UASs is the ability to carry payloads that collect data including imaging devices. Current technologies for commercial use include both fixed wing and rotor aircraft. This study was limited to rotor aircraft as this type of UAS is more suitable for bridge safety inspections. Due to a rotor aircraft's maneuverability, ability to collect data above head and at an angle, and the ability to get within close proximity of the structure is important for an inspection application. Fixed wing aircraft work well for overhead data collection only, such as agriculture and purely aerial mapping, and allows a pilot to cover longer distances and map larger areas more easily.

4.1 COMMON CURRENT TECHNOLOGY

There are several UASs on the market that are potentially suitable for inspection work. While technologies and capabilities differ, the most common inspection specific UASs' share these general features:

- Powered by rechargeable batteries.
- Controlled either autonomously or with a remote control device,
- Contain 4 to 8 rotors, commonly referred to a quadcopter and octocopter.
- Ability to use GPS to track location, and the ability to operate in a GPS denied environment.
- Contain fail safes such as return to home technology.
- Includes a camera with both video and still image capabilities.
- Thermal sensors.
- Object sensing and avoidance.
- Ability to pre-program autonomous missions.

4.1.1 Project Technology

For Phase II of the study, our team utilized the senseFly Albris drone, which was designed for commercial inspection and mapping purposes. This model has the ability to fly under bridge decks and to look straight up, which are two critical missing features identified in the Phase I study. The Albris drone can be controlled interactively with a controller or autonomously with a pre-programmed flight. Both flight modes utilize a laptop computer to control the UAS. The flight control software contains the drone's settings, which include a real time map that displays the drone's location, live image views, and flight data. The software can also be used to plan and monitor autonomous flights.

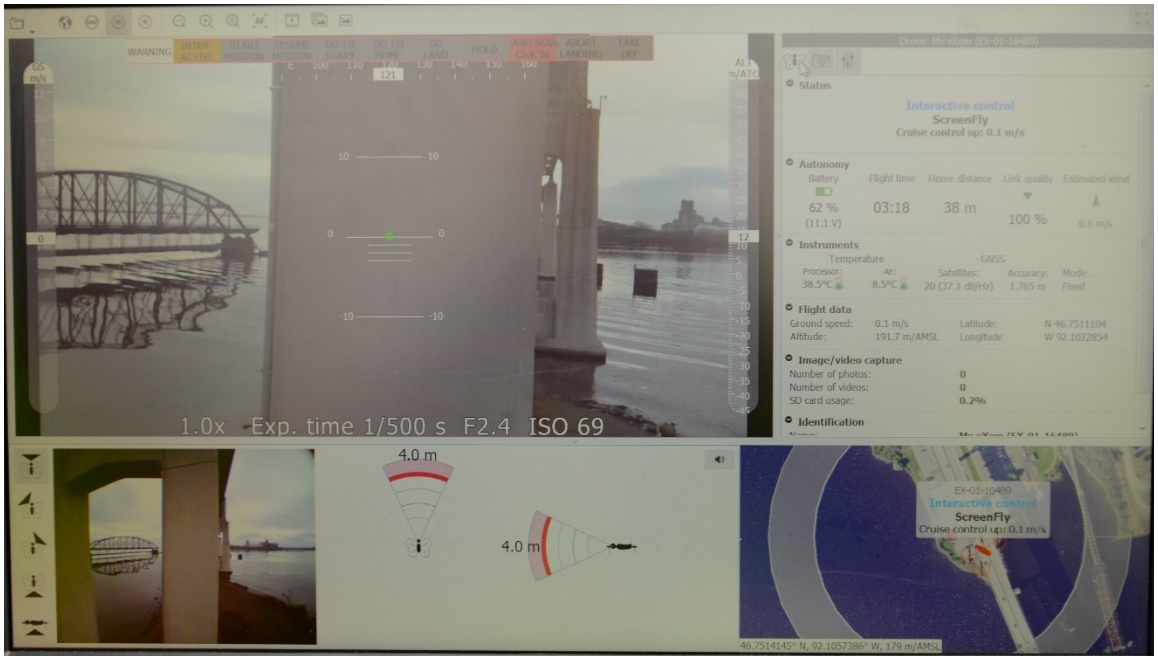

Figure 4-1 Flight Control Screen.

Figure 4-2 Photograph of the senseFly Albris UAS Under a Bridge.

4.2 FUTURE TECHNOLOGY

Drone technology has advanced rapidly since our Phase II study began. The ability to look straight up and to fly without GPS under bridge decks was a major improvement in the evolution of Phase II. Opportunities still exist to improve the capabilities of UASs for bridge inspection including advanced object sensing, object avoidance, and technologies that would allow for inspections in confined spaces.

One technology we have identified as potentially useful, is a UAS designed specifically for confined spaces that will allow even closer inspection of difficult to access areas. During Phase III, we will be working with a drone that is enclosed in a cage that makes the drone collision tolerant. http://www.flyability.com/elios/

Figure 4-3 Photograph of the Flyability Elios UAS.

4.3 SAFETY ANALYSIS

UASs have come under scrutiny due to safety and privacy concerns. This study provided an opportunity to evaluate the safety of UAS use from the perspective of both an inspection team and the traveling public.

Most UASs, including the senseFly Albris, have built in safety features to reduce the risk involved. The Albris weighs less than four pounds, which reduces the damage potential if an impact were to occur. The senseFly Albris has propeller shrouds which protect any object or person from possible contact with the propellers. This protection not only reduces the possibility of injury, but also reduces the risk of a crash resulting from the UAS propellers.

There are also several fail safes built into the device, including a return-to-home function should communication with the pilot and the ground control point be lost. The Albris has five navigation cameras and five ultrasonic proximity sensors to help the drone navigate and avoid objects.

Bridge inspection safety plans and job hazard analyses were implemented for each inspection, as is typical for all bridge inspections. On-site safety briefings with all team members were performed before any flights took place. Particular attention was paid to the safety of the public by displaying signage where appropriate to warn the public that drone inspection operations were underway. The work area and drone landing area were well marked with cones, and inspection staff wore personal protection equipment (PPE) at all times, such as hard hats, high visibility vests, and eye protection. An example safety plan is included in Appendix A.

Figure 4-4 Safety Signage.

In Phase II of the UAS study, our team performed numerous flights without incident. Based on this experience, operating the UAS while following safety procedures presents a very low risk to inspection personnel and to the general public. When compared to other traditional access methods where traffic control and large equipment is required, the risk was observably much lower. As part of the FAA's Part 107 rules, an accident reporting requirement is included as follows:

> **§ 107.9 Accident Reporting.** No later than 10 days after an operation that meets the criteria of either paragraph (a) or (b) of this section, a remote pilot in command must report to the Federal Aviation Administration in a manner acceptable to the Administrator, any operation of the small unmanned aircraft involving **at least:**
>
> a. Serious injury to any person or any loss of consciousness; or
> b. Damage to any property, other than the small unmanned aircraft, unless one of the following conditions is satisfied:
>   1. The cost of repair (including materials and labor) does not exceed $500; or
>   2. The fair market value of the property does not exceed $500 in the event of total loss.

CHAPTER 5: BRIDGE INVESTIGATION METHODS AND RESULTS

The following describes the investigative methods and results for each bridge in the study. The location, structure description, access methods, investigation methods, site specific safety analysis and imagery results are detailed per bridge.

5.1 BRIDGE 9030 –DULUTH, MN

5.1.1 Location

Bridge 9030, John A. Blatnik Bridge, is located between Duluth, Minnesota and Superior, Wisconsin. The bridge carries I-535 and US 53 over the St. Louis River, a railroad, and several local roadways.

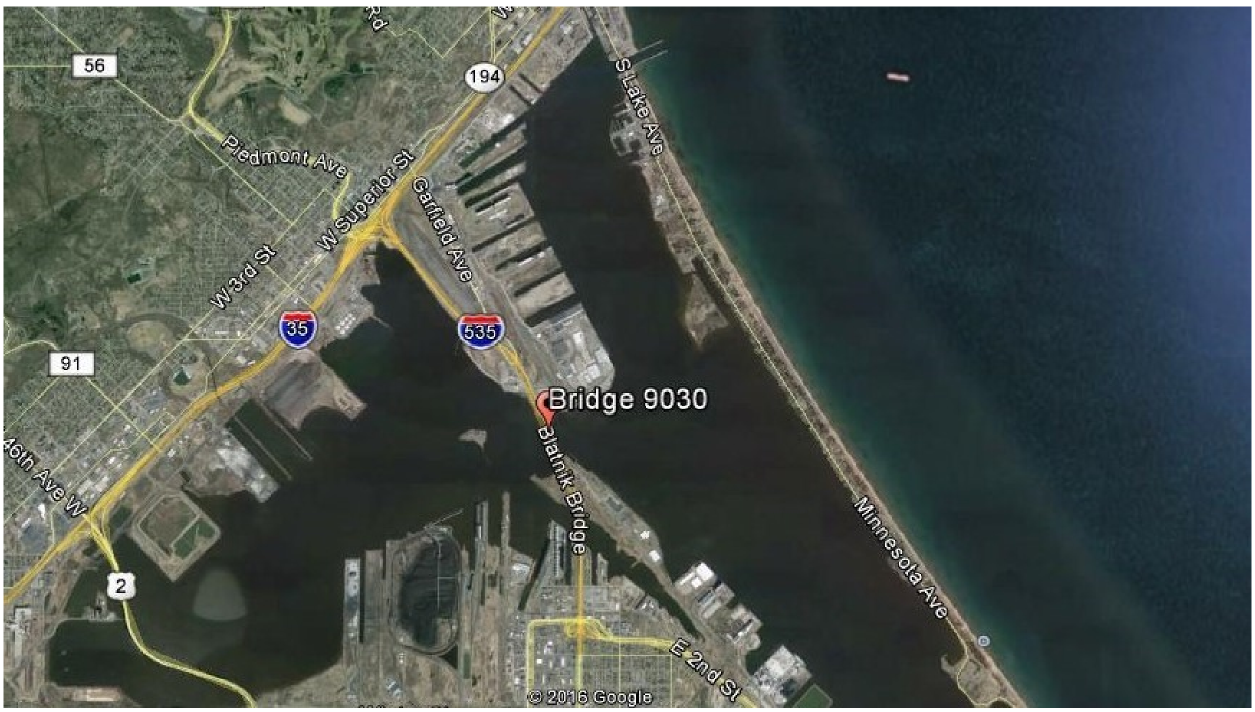

Figure 5-1 Bridge 9030 Overall Map.

5.1.2 Structure Description

Bridge 9030 is a 7,980 foot long bridge constructed in 1961. The main span is an open spandrel steel arch with steel deck trusses at each adjacent span, refer to Figure 5-2 below. The approach spans consist of continuous steel beam spans, refer to Figure 5 2 below.

Figure 5-2 Bridge 9030 Main and Adjacent Spans, Looking East.

Figure 5-3 Bridge 9030 North Approach Spans, Looking Northeast.

5.1.3 Access Methods

The drone was launched and flown from locations that were within the limits of the normal MnDOT inspection which generally includes areas immediately under and adjacent to the bridge. The UAS was flown mainly from the parking lot near the north end of the bridge and the vacant area near the south end of the bridge.

5.1.4 Investigation Methods

The bridge was viewed with the use of UAS technology to determine the UAS's effectiveness as a tool for bridge safety inspection. The main goal of this effort was to determine if a UAS could be flown on a large scale bridge and to compare the results to normal inspection methods.

5.1.5 Site Specific Safety

Since this work was performed prior to the Part 107 rules taking effect, the UAS was flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. The Minnesota Department of Transportation's Office of Aeronautics was notified prior to field work. The UAS was flown such that it was never directly overhead of the public, and maritime traffic under the bridge was monitored in order to ensure the safety of the public. Visual observers monitored boat traffic and communicated the presence of approaching vessels to the UAS operator by radio. The inspection team wore proper personal protection equipment at all times including hard hats, safety glasses, and reflective vests.

5.1.6 Investigation Results

Results from the Blatnik Bridge inspection demonstrated that the UAS could be utilized on a large scale inspection in challenging weather conditions. The bridge is a long span steel truss that accommodates high average daily vehicle traffic over a busy shipping channel. The bridge is located in an area with high winds and quickly changing weather, which made it the most challenging bridge to inspect from an access standpoint.

MnDOT was conducting their inspection concurrently with the UAS inspection. Four inspection teams were present with four under bridge inspection vehicles (UBIV) and a lift. Traffic control was established to close lanes in order to conduct the inspection.

The inspection senseFly Albris was safety tested by bumping the UAS into the pier near the ground. The ultrasonic sensors were also tested to demonstrate the distance sensing capabilities of the drone. All safety analysis tests confirmed the Albris's resiliency and ability to overcome or avoid obstacles.

Benefits from the inspection-specific UAS include the ability to fly under the bridge and view the underside of the deck. The image quality was comparable to a close up photograph. The ability to fly close to the bridge proved to be very beneficial for high quality inspection results.

A second monitor was utilized to give the inspector a live view of the inspection and the ability to manipulate the camera while the UAS pilot flew the drone.

Figure 5-4 Photograph of Blatnik Bridge Second Monitor Set-up

To view video of the Blatnik Bridge Investigation, visit the following link:

https://youtu.be/-OKOlap286k

The figures below show the level of detail attained with the UAS.

Figure 5-5 Photograph of Blatnik Bridge Underside of Deck.

Figure 5-6 Photograph of Blatnik Bridge West Fascia Beam.

Figure 5-7 Photograph of Blatnik Bridge Bearing.

Figure 5-8 Photograph of Blatnik Bridge Underside Truss and Deck.

Figure 5-9 Photograph of Blatnik Bridge Underside Truss and Deck.

Figure 5-10 Photograph of Blatnik Bridge Underside Truss Connection.

Figure 5-11 Photograph of Blatnik Bridge Pier Cap Detail.

Figure 5-12 Photograph of Blatnik Bridge Pier at Waterline.

5.1.7 Cost Comparison

A cost comparison was conducted based on the inspection of the Blatnik Bridge, contrasting a UAS inspection versus traditional inspection access methods. The cost comparison is based on the approach spans only. The fracture critical main truss spans require a hands on inspection.

Based on the traditional methods, this bridge would typically utilize four snoopers (inspection vehicles), an 80 foot man-lift, and require eight total inspection days. This equates to a minimum cost of approximately $59,000 for an inspection using conventional equipment, (not including equipment mobilization and travel expenses).

The cost of a UAS contract to inspect all of these same approach spans of this sample bridge would be around $20,000 with only 5 days onsite per consultant-obtained quote. This is a potential cost savings of up to 66 percent or roughly $40,000. Details of the cost comparison can be found in Chapter 6 of this report.

5.2 BRIDGE 5767 – NIELSVILLE, MN

5.2.1 Location

Bridge 5767 is located west of downtown Nielsville, MN, carrying CSAH 1 over the Red River. Field work was completed on April 20th, 2016 by Dan Stong of RDO. This work was performed prior to Part 107 and utilized RDO's 333 Exemption.

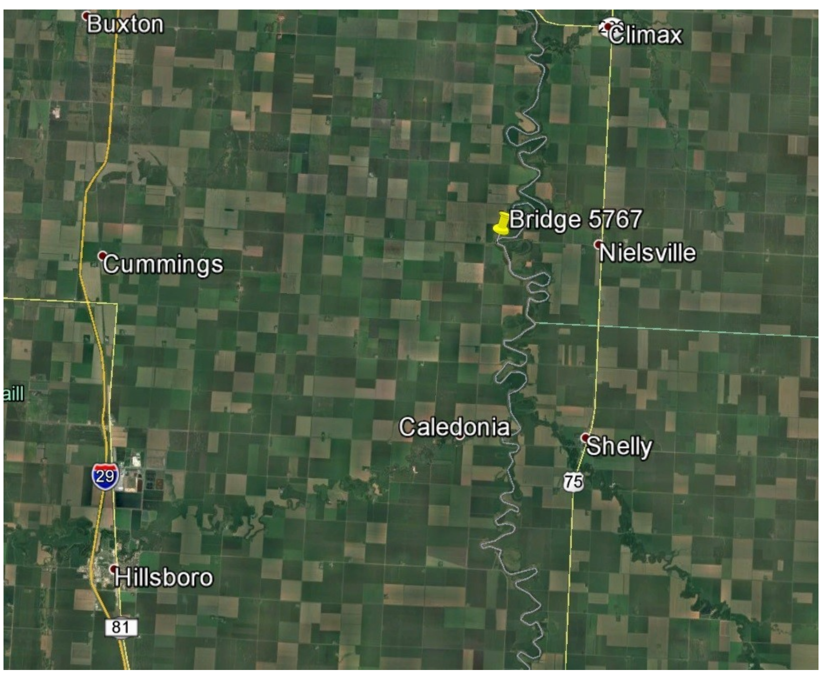

Figure 5-13 Aerial Map of Bridge 5767's Location.

5.2.2 Structure Description

Bridge 5767 is a two span 362 foot long steel high truss. The bridge was constructed in 1939. The bridge was closed in September of 2015 due to structural deficiencies with the bridge deck.

Figure 5-14 Overall View of Inspection.

5.2.3 Access Methods

The bridge was accessed from both river banks and the top of the bridge deck, since the bridge is closed to traffic. The UAS was flown above the bridge to investigate the top of the bridge's truss system and inside of the truss to evaluate the top of the bridge deck. Each side of the bridge was flown from one end to the other to observe the respective fascia. The UAS was also flown underneath the bridge to examine the underside of the bridge's deck and substructures. All access locations used were within the limits of a typical MnDOT inspection which generally include areas immediately under the bridge and adjacent to the bridge.

5.2.4 Investigation Methods

The bridge was inspected with the use of UAS technology to determine the UAS's effectiveness as a tool for bridge safety inspection. The main goal of this inspection was to test the thermal sensor capabilities of the Albris in detecting deck delaminations. Using traditional methods, the bridge was first chain dragged in order to locate and mark observed deck delaminations. The drone was then flown over the bridge with the thermal sensor active while thermal images were collected. Handheld FLIR thermal cameras were also used as a comparison.

5.2.5 Site Specific Safety

Permission from the nearby Nielsville Airport was obtained from the airport manager, and the MnDOT Office of Aeronautics was notified prior to field work. A job hazard analysis and a high work plan were prepared and were utilized to facilitate daily site safety briefings. Both documents can be found in Appendix A.

The bridge is currently closed with no traffic. The UAS was flown in accordance with Collins' Engineers' FAA Section 333 Exemption and the FAA blanket Certificate of Authorization. The UAS was piloted as such that it never flew directly over the public. The inspection team wore the proper personal protection equipment at all times including hard hats, safety glasses, and reflective vests.

5.2.6 Investigation Results

Comparing the results of the chain dragging and FLIR thermal camera, the Albris demonstrated that the onboard thermal sensor was able to detect the deck delaminations with good accuracy, shown in Figures 5-14 and 5-15 below.

To view the video of the investigation of the 3D model for Bridge 5767, visit the following link:

https://youtu.be/fZwsx_YtUOw

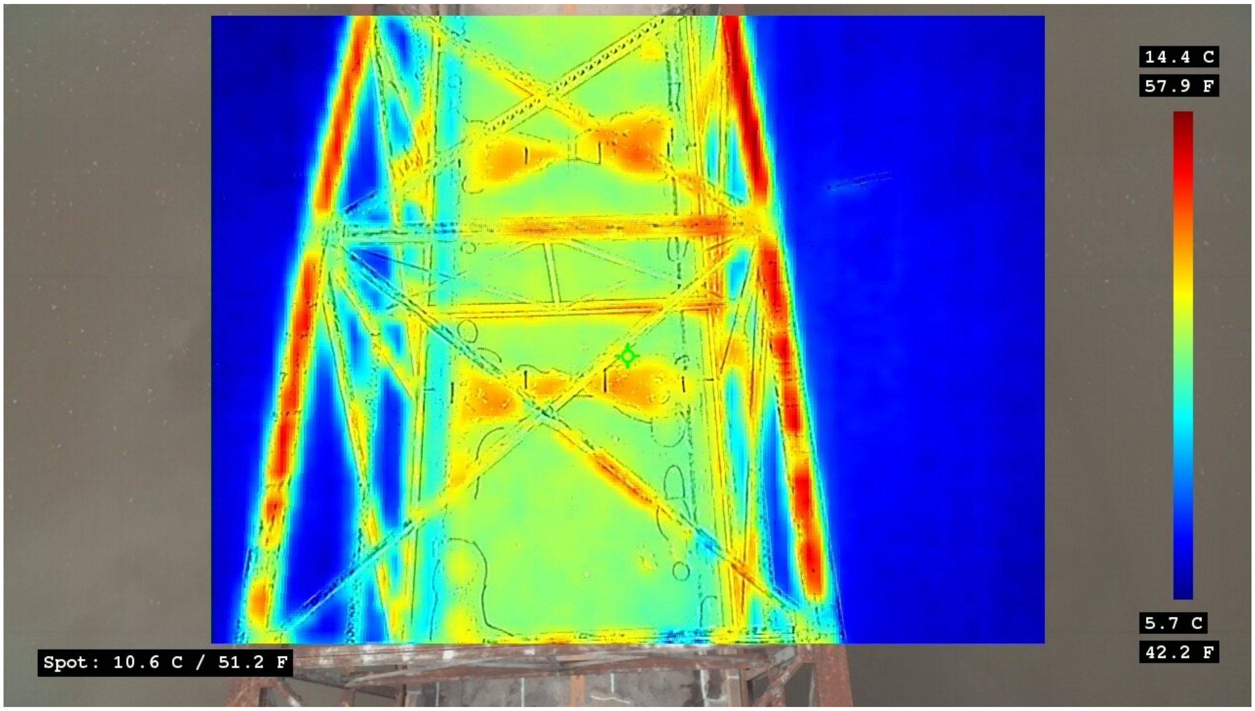

Figure 5-15 Bridge 5767 Deck Drone Thermal Images.

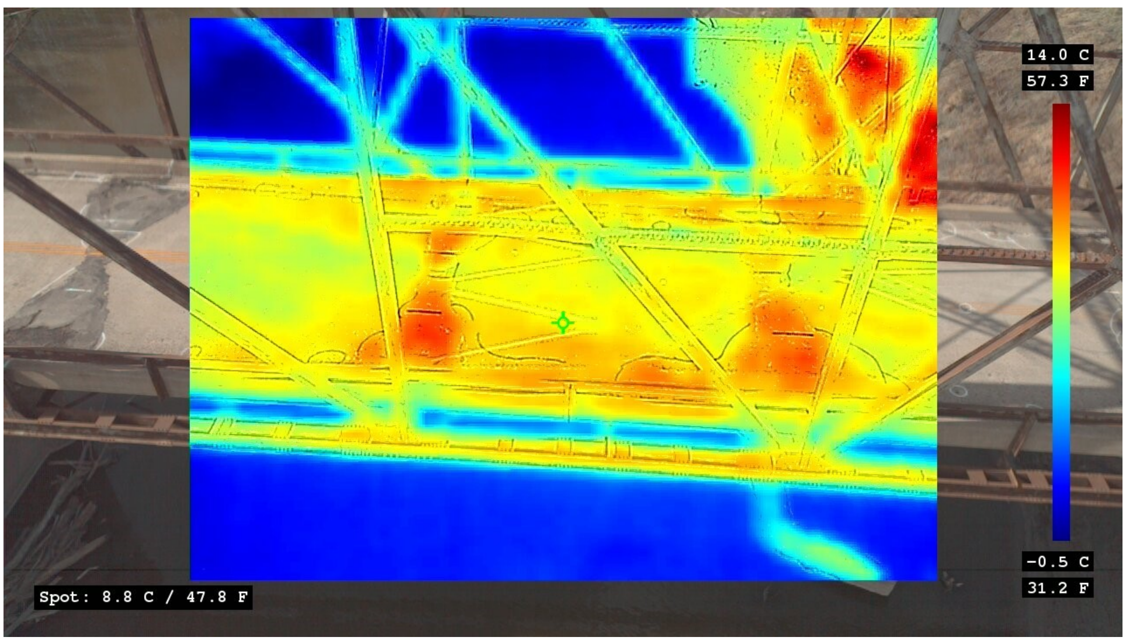

Figure 5-16 Bridge 5767 Deck Drone Thermal Image.

5.2.7 Bridge Mapping Mission

The drone was also used to create a three dimensional model of the bridge and bridge site. Photos were taken with the drone at many different locations and angles in order to generate enough data to create a model. The photos were processed with Pix4D mapping software, and the following model was generated.

Figure 5-17 Bridge 5767 3D Model.

To view video of the investigation of the 3D model of Bridge 5767, visit the following link:

https://youtu.be/fNjkl6y93l8

5.3 BRIDGE 62513 – SAINT PAUL, MN

5.3.1 Location

Bridge 62513 carries Shepard Road (MSAS 194) in Saint Paul, Minnesota. Field work was completed on July 28th, 2016 by Collins Engineers.

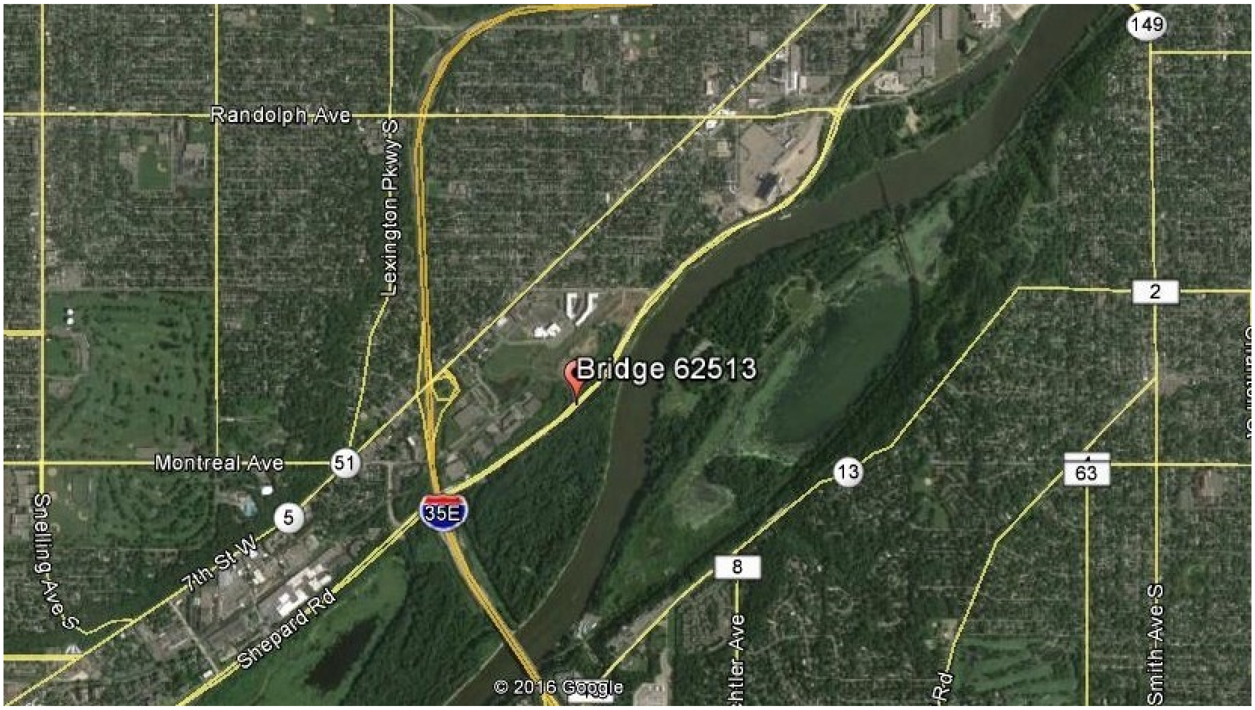

Figure 5-18 Bridge 62513 Aerial Map.

5.3.2 Structure Description

Bridge 62513 is a 263-foot long corrugated steel culvert that spans approximately 22 feet. Originally constructed in 1965, the barrel was extended at both ends in 1993.The inventory and inspection report can be found in Appendix A as part of the Bridge Investigation and Safety Plan.

Figure 5-19 Bridge 62513 Overall View.

5.3.3 Access Methods

The culvert was accessed from both barrel ends, and the UAS was flown end to end to investigate the interior of the barrel. The UAS was launched and flown from locations that were within the limits of typical MnDOT inspection, which generally include the areas immediately inside of the barrel. The roadway above the culvert was not flown as part of this investigation.

5.3.4 Investigation Methods

The main focus of this effort is to study the effectiveness of a UAS inspection in culvert barrels. This culvert was chosen for the study to evaluate the ability to utilize UAS in a confined space without GPS signals. The UAS was flown in no GPS mode. While most culverts typically accommodate constant water flow, the culvert chosen was dry at the time of inspection. This allowed our team to evaluate the culvert without the risk of landing the drone in the water.

5.3.5 Site Specific Safety

Bridge 62513 was located in a wooded area owned by the city of St. Paul with no public access on either side of the culvert barrel. The Minnesota Department of Transportation's Office of Aeronautics was notified prior to field work. The UAS was flown such that it was never outside of the barrel, and as a result the drone was not in national air space. The inspection team wore the proper personal protection equipment at all times including hard hats, safety glasses, and reflective vests.

5.3.6 Investigation Results

Our team was able to fly the UAS longitudinally through the culvert taking photos and video of the interior (Figure 5-19). Photo and video quality were good and provided enough detail to discern deficiencies. The LED light and flash were able to illuminate the structure to improve the quality of photos and video.

While this method generally worked well, it became apparent that piloting skills were more important without active GPS versus flying in the open with GPS assistance. Another challenge was that the UAS kicked up dust as it took off and when flying within a few feet of the ground. This dust degraded the photo and video quality somewhat but did not affect the UAS itself.

To view video of the Culvert Investigation visit the following link:

https://youtu.be/uqNDtLW0yLI

Figure 5-20 Photograph of Culvert Interior Wall.

5.4 STILLWATER LIFT BRIDGE RAILING ASSESSMENT

5.4.1 Location

The Stillwater Lift Bridge is located in downtown Stillwater, MN and crosses the St. Croix River into Wisconsin. Field work was completed on December 9th, 2016, and the drone was flown by Barritt Lovelace.

Figure 5-21 Stillwater Lift Bridge Overall Map.

5.4.2 Structure Description

The Stillwater Lift Bridge carries State Highway 36 over the St. Croix River between Stillwater, Washington County, Minnesota, and Houlton, Wisconsin. Constructed in 1931, the 10-span bridge includes six steel Parker through truss spans, one movable span of the type commonly known as a "Waddell and Harrington vertical lift," and three concrete slab approach spans.

The UAS was generally launched and flown from locations that were within the limits of a normal MnDOT inspection, which customarily include areas immediately under and adjacent to the bridge. The UAS was not flown over private property or pedestrian traffic at any time, and efforts were made to not include the public in any media recordings during the fieldwork.

5.4.3 Investigation Methods

The Stillwater Lift Bridge is currently undergoing a rehabilitation design. The intent of the inspection was to gather information to assist the designers in determining the condition of the north railing without having to close the bridge or to require traffic control. The UAS was launched and flown from a public area immediately northeast of the bridge. The UAS was not flown over private property or pedestrian traffic at any time. The railing on the north side of the bridge was investigated with the use of the Albris UAS and was documented with both photos and video.

5.4.4 Site Specific Safety

The UAS was flown in accordance with the Part 107 FAA Rules as field work was completed after the June 2016 regulation was announced. The UAS was flown such that it is never directly overhead of the public. The inspection team wore the proper personal protection equipment at all times including hard hats, safety glasses, reflective vests.

Figure 5-22 Photograph of Stillwater Lift Bridge Setup.

5.4.5 Investigation Results

The Stillwater Lift Bridge is currently undergoing a rehabilitation design. The intent of the inspection was to gather information to assist the designers in determining the condition of the north railing without having to close the bridge or to require traffic control.

The UAS was flown from end to end using the Albris' cruise control feature and automatic photo triggers. HD video was also taken and the photos and videos were used to determine the condition of the railing and was useful in the decision to ultimately replace the railing. This effort provided the designers with enough information to make an informed decision on whether to replace the railing and was done cost effectively without disrupting traffic at any time. The alternative would have included traffic control and would have been considerably more expensive and time consuming.

The ability to investigate the railing from a safe distance from traffic was very beneficial and the entire effort took less than three hours.

To view video of the railing investigation, visit the following link:

https://youtu.be/yxYgYbmk0hA

Figure 5-23 Overall View of Bridge 4654, Stillwater Lift Bridge.

Figure 5-24 Typical Railing View.

CHAPTER 6: INSPECTION COST COMPARISON

A cost comparison based on the inspection of Duluth's Blatnik Bridge multi-girder approach spans was conducted contrasting a UAS inspection with a traditional access methods inspection. Based on the traditional methods of inspection, this bridge would utilize four inspection vehicles (snoopers), an 80 foot man-lift, and require eight total inspection days. This equates to a minimum cost of approximately $59,000 using conventional equipment. This does not consider the additional cost of equipment mobilization and travel expenses. The cost of a UAS contract to inspect these same approach spans of this bridge would be around $20,000 with only 5 days onsite, per a consultant-obtained quote. This is a potential cost savings of 66 percent or nearly $40,000 in this case. (All calculated costs are based on rates from January 2016.)

Table 6-1 Cost Estimate for a Traditional Access Methods Inspection of the Blatnik Bridge.

Equipment/Personnel	Cost	Unit
Vehicle		
Snooper	$9.58	per mile
Class 33	$4.42	per mile
6 Pack Truck	$1.57	per mile
Half Ton Truck	$0.84	per mile
Traffic Control		
Attenuator	$4.00	per day
Message Board	$3.00	per day
Personnel		
TG	$40.00	per hour
TGS	$43.41	per hour
ES	$56.35	per hour

Miles Driven for Inspection	20	miles
Hours at inspection	8	hours

Cost per Snooper Unit	$2,452.36
Assuming 1 ES, 2 TGs, 3 TG	

Number of Snoopers Used	3	trucks
Number of Inspection Days	8	days

TOTAL SNOOPER INSPECTION COST	$58,856.64
DRONE CONTRACT	$20,000.00

SAVINGS PERCENTAGE	66.02%

CHAPTER 7: BEST PRACTICES AND SAFETY GUIDELINES

A set of best practices and safety guidelines has been prepared and will be considered an addition to the *MnDOT Bridge and Structure Inspection Program Manual* as the technology becomes more prevalent. This document is located in Appendix C.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

Based on our observations in the field and extensive literature research, the following conclusions were made:

- An UAS can be used safely and effectively on large bridges in challenging conditions.
- An UAS can be used in GPS deprived environments, but piloting skills become more important.
- An UAS is more suitable as a tool for inspection of bridges with elements that are difficult to access.
- UASs cannot perform inspections independently and should be used as tools for qualified and experienced bridge inspectors to view and assess bridge element conditions in accordance with the National Bridge Inspection Standard (NBIS).
- An UAS used in conjunction with thermal sensors can be an effective way to detect concrete delaminations and can be done without closing the bridge to traffic by flying adjacent to traffic lanes.
- Measurements can be estimated from images, but tactile functions (e.g., cleaning, sounding, measuring, and testing) equivalent to a hands-on inspection cannot be replicated using UASs.
- The ability to direct cameras 90 degrees upward and the ability to fly without a GPS signal are important features when using this technology as an inspection tool.
- UAS technology is evolving rapidly and inspection-specific UAS features are just coming into the marketplace that will increase their performance as it relates to bridge safety inspection.
- In some types of inspections, an UAS has the capabilities to be used in lieu of an under-bridge inspection vehicle and would provide significant savings. These savings would come in the form of reduced or eliminated traffic control and reduced use of under bridge inspection vehicles and lifts.
- UASs can provide a cost-effective way to collect detailed information that may not normally be obtained during routine inspections.
- Safety risks associated with traffic control, working at heights and near traffic could be reduced with the use of UASs.
- UASs can provide important pre-inspection information for planning large-scale and for emergency inspections. Information such as clearances, rope access anchor points, and general and current conditions can easily be secured with an UAS to aid in the planning of an inspection.
- UAS inspection techniques developed through bridge inspection research, could also be utilized for the inspection of retaining walls, high mast light poles, and various other structures.
- Utilizing UAS in conjunction with photogrammetry software can provide a three dimensional model and point cloud of a bridge and bridge site that is valuable in determining unknown dimensions and provides a high quality inspection report deliverable.

Based on the information presented in this report, the following recommendations are made:

- The use of a UAS to aid bridge inspection should be considered as a tool to a qualified Team Leader only when a hands-on inspection is not required.
- The use of UASs to aid bridge inspections should be considered for routine inspections of bridges or any structure to improve the quality of the inspection by collecting data that may not be readily obtained without expensive access methods.
- UASs should also be considered where increased safety for inspection personnel and the traveling public can be achieved without compromising inspection quality.
- As part of the Phase III Study, collision tolerant UASs should be investigated for use in tight and confined spaces such as truss bridges, box girders, sewers, tunnels and any confined location where the technology’s use is applicable.

REFERENCES

1. Federal Highway Administration, *National Bridge Inspection Standards* (December, 2004), 23 CFR 650, FHWA, Washington, DC.

2. U.S. Department of Transportation (2012), *Bridge Inspector's Reference Manual*, Federal Highway Administration, Washington, DC.

3. Minnesota Department of Transportation (May, 2016), *Bridge and Structure Inspection Program Manual*, MnDOT Office of Bridges and Structures, Oakdale, MN

4. J. Koonce, T. Demski, M. Rowe, N. Morris (2011) "Bridge Inspection Access to Minimize Operational Impacts," American Railway Engineering and Maintenance of Way Association, 2011 Annual Conference, October 2011, Collins Engineers, Inc., Chicago, IL.

5. P. Moller (2008) *CALTRANS Bridge Inspection Aerial Robot*, Report CA 08-0182, California Department of Transportation, Davis, CA.

6. F. Khan, A. Ellenberg, S. Ye, A.E. Aktan, F. Moon, A. Kontsos, A. Pradhan, and I. Bartoli, (August, 2014) "Multispectral Aerial Imaging for Infrastructure Evaluation," ASNT Structural Materials Conference 2014, Charleston, SC, October 2014

7. Federal Aviation Administration (2016). Internet. Unmanned Aircraft Systems, (Accessed August 2016) https://www.faa.gov/uas/.

APPENDIX A: BRIDGE INVESTIGATION AND SAFETY PLANS

Unmanned Aerial Vehicle Bridge Inspection Demonstration Project Phase II

Investigation and Safety Plan

10/22/15

Prepared for:

MINNESOTA DEPARTMENT OF TRANSPORTATION

Prepared by:

COLLINS ENGINEERS INC.

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St. Paul, MN 55104
651.646.8502 • www.collinsengr.com

PROJECT SUMMARY

Project: Unmanned Aerial Vehicle Bridge Inspection Demonstration Project Phase II

Purpose of Project: The overall goal of the Unmanned Aerial Vehicle (UAV) Bridge Inspection Demonstration Project is to study the effectiveness of UAV technology when applied to bridge safety inspections.

Field Team:

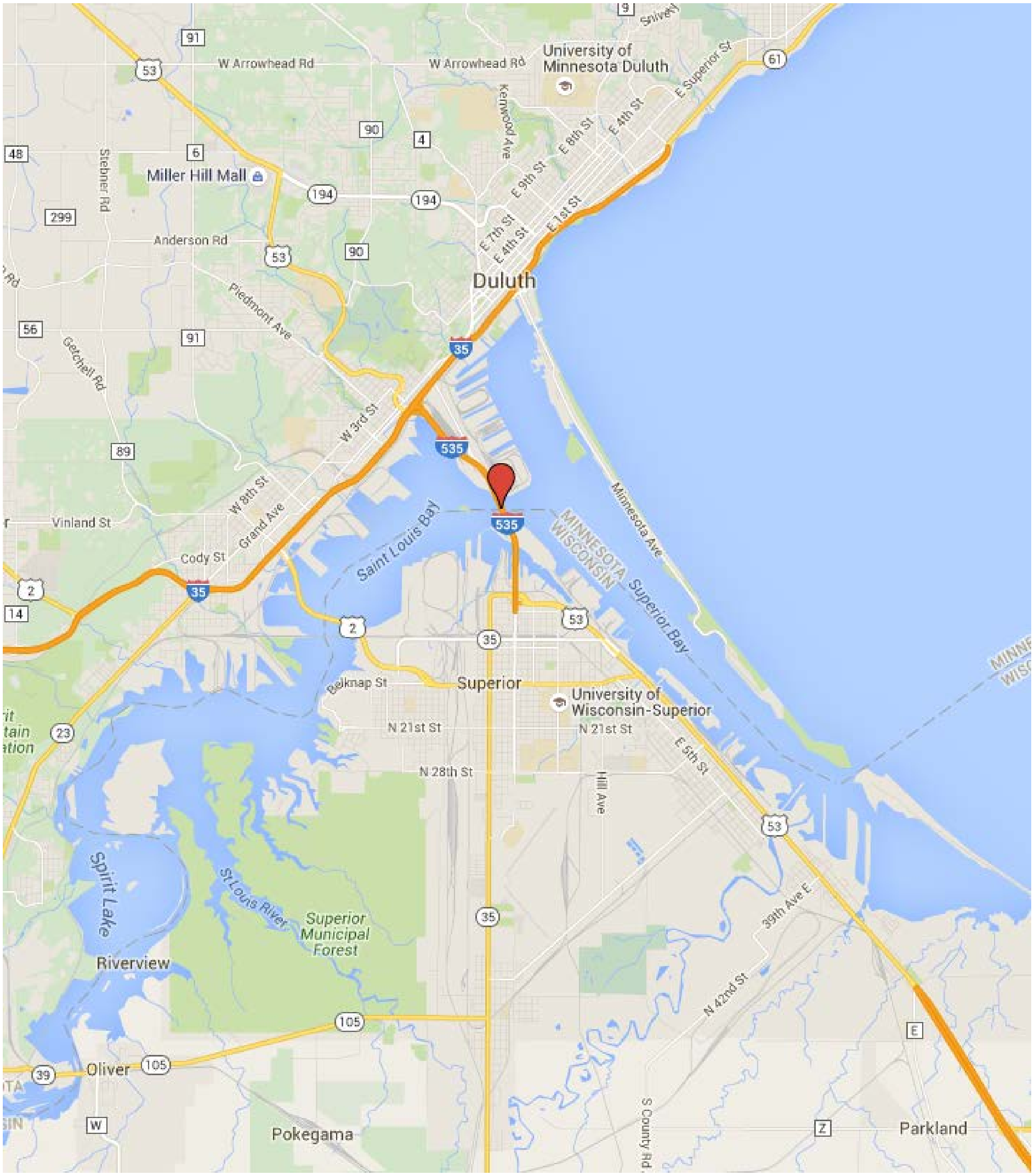
Jennifer Zink - MnDOT Project Manager
Barritt Lovelace – Collins Engineers - Project Manager, Quality Mangement
Dave Prall – Unmanned Experts - UAV Pilot in Command
Keven Gambold – UAV Administrator
Dan Stong – RDO - UAV Operator
Adam Zylka – Sensefly - UAV Operator
Beverly Farraher – MnDOT Project Champion

Field Date(s): November 2nd – 6th, 2015, Working Hours 7:30 am – 5 pm ; Lane Closure 8:30 am – 3pm

Tentative Schedule				
Monday 2nd	Tuesday 3rd	Wednesday 4th	Thursday 5th	Friday 6th
Site Safety Meeting/Approach Spans	Approach Spans	Media Event/Main Truss	Main Truss	Weather Day

Project Location: Bridge 9030, Blatnik Bridge over the St. Louis River, Duluth, MN

Map: Google Map of Bridge Site
https://www.google.com/maps/d/edit?mid=zWY1TJfvKcUc.kJVxSS5D8Xg8&usp=sharing



Overall Bridge Location Map

COLLINS ENGINEERS INC.

1.0 INTRODUCTION

1.1 Project Overview

Increasing bridge maintenance and inspection costs are a concern for existing bridges in Minnesota. These additional costs can be minimized and the quality of inspections can be improved by utilizing Unmanned Aerial Systems (UAS). In the summer of 2015 MnDOT performed a Phase I study to evaluate the use of UAS for bridge inspections and the resulting study was published by the MnDOT Research Office. Based on the conclusions and recommendations of the first study the overall goal of this Phase II contract is to further evaluate the effectiveness of UAS as they applies to Bridge Safety Inspections. This project will involve utilizing UAS to evaluate three structures to determine their effectiveness in as a tool for bridge safety inspections. The structure types include a steel box girder, a steel culvert and through arch bridge. The Sensefly eXom, an inspection specific UAS will be utilized to conduct the fieldwork. The study will culminate in a report detailing newer technology that is specific to inspection, a cost comparison to traditional access methods, and advantages and disadvantages of using the UAS during an actual inspection. The project will also include the development of a UAS best practices document based on the results of the study.

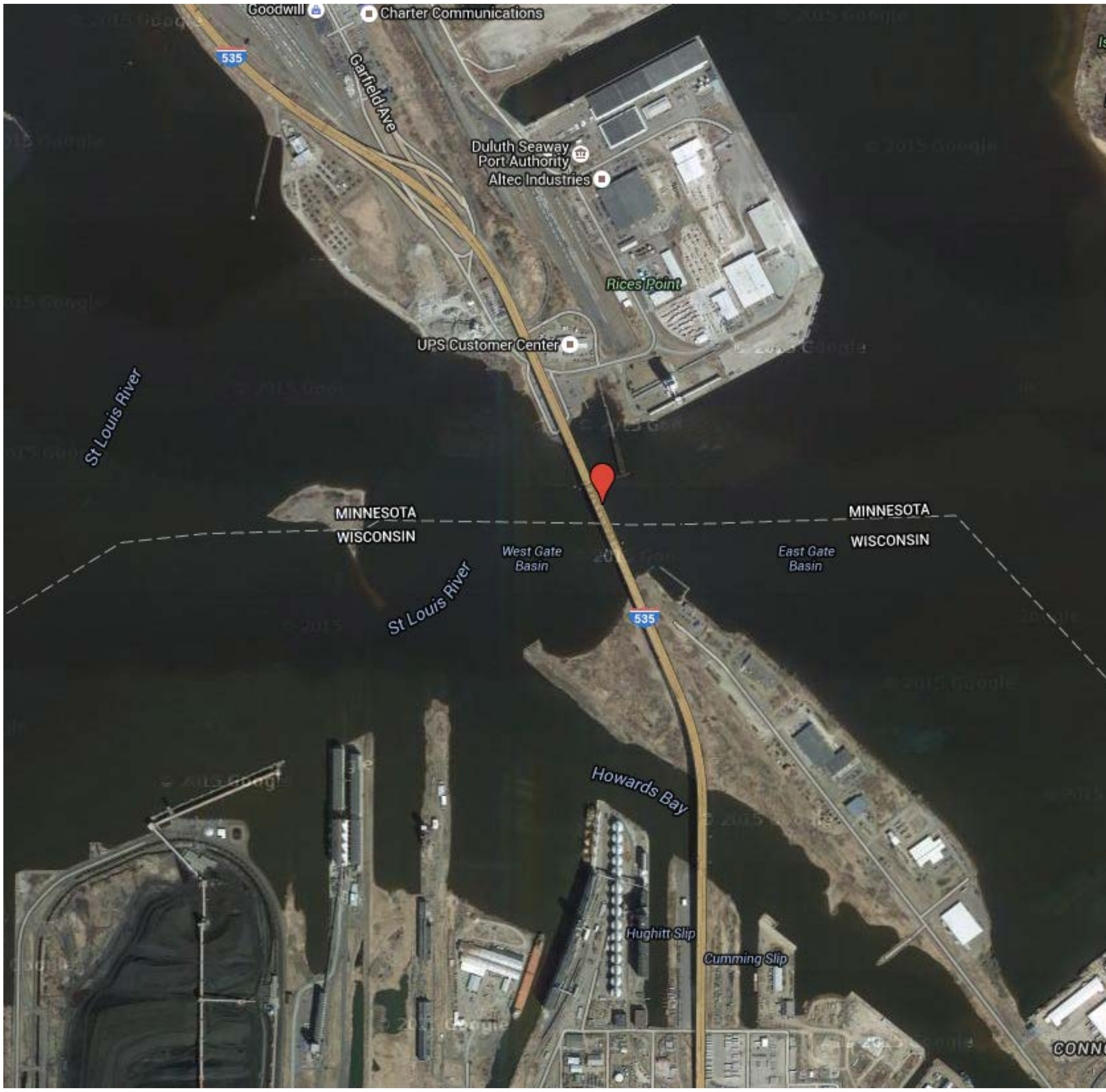
2.0 INVESTIGATION PLAN

The following describes the inspection plan for the Blatnik Bridge. The location, structure description, access methods, investigation methods and a site specific safety analysis are detailed below.

2.1 Bridge 9030 – Blatnik Bridge

2.1.1 Location

Bridge 9030 is located in Duluth, Minnesota and Superior Wisconsin. The bridge carries I-535 over the St. Louis River, a railroad and several local roadways.



2.1.2 Structure Description

Bridge 9030 is a 7,980 foot long bridge constructed in 1961. The main span is an open spandrel steel arch with steel deck trusses at each adjacent span. The approach spans consist of continuous steel beam spans. The inventory and inspection report can be found in Appendix B.

2.1.3 Access Methods

The bridge will be accessed from both the river banks and from the top of deck. Each fascia of the bridge will be flown from one end to the other to investigate the sides of the bridge. The bridge will also be flown from underneath to investigate the underside of deck, substructures and the prestressed beams. The top of the bridge will be flown to investigate the top of deck. The UAS will be flown from the parking lot near the north end of the bridge and the vacant area near the south end of the bridge. The MnDOT Hydraulics Unit boat will be used to fly the main spans as needed. The boat can be launched from the boat ramp near the north shore under the bridge.

Staging Areas

2.1.4 Investigation Methods

The bridge will be inspected with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAV. Any additional deficiencies discovered will be noted as well.

2.1.5 Site Specific Safety

2.1.5.1 Airspace safety is addressed in the Pre Site Survey Brief prepared by Unmanned Experts located in Appendix D.

2.1.5.2 The bridge accommodates roadway traffic and the UAV will be flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Traffic control will be set up in conjunction with the bridge inspection being performed by MnDOT. The UAV will be flown such that it is never directly overhead the public. The inspection team will wear the proper personal protection equipment at all times including hard hats, safety glasses and reflective vests. When operating from the boat all personnel shall wear personal flotation devices.

Respectfully Submitted,

COLLINS ENGINEERS, INC.

Barritt Lovelace, P.E., Regional Manager

Appendix A

Job Hazard Analysis

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION

Submit to Project Manager / Supervisor for approval prior to commencing work if necessary.

PROJECT INFORMATION:

Collins Project Number:	9029	Date:	10/27/2015
Client:	MnDOT	Prepared By:	Barritt Lovelace
Inspection Team Leader:	Barritt Lovelace	For Date(s):	Nov. 2nd - Nov 6th, 2015
General Work Location:	Blatnik Bridge, Duluth, MN	Expected Work Duration:	Nov. 2nd - Nov 6th, 2015

REQUIRED SAFETY EQUIPMENT FOR INSPECTION CHECK LIST:

(Check if in Possession; obtain all applicable and required equipment prior to commencing work)

Personal Protective Equipment (PPE)		General Equipment		First Aid / Other:	
Hard Hat:	X	Project Work Plan:	X	First Aid Kit:	X
Safety Glasses:	X	GPS/Atlas/Maps:	X	Sunscreen:	X
Steel Toe Boots:	X	Harness:		Insect Repellent:	
Gloves:	X	Stress Release Straps for Harness:		Drinking Water:	X
Hearing Protection:		Lanyards:	X	Strobe Lights:	X
Reflective Vests:	X	Tethers for Climbing Tools:		Two-Way Radios:	X
Reflective Pants (night work):		Personal Floatation Device:	X	Mobile Phone:	X
Rope Access Equipment:		:		:	
:		:		:	

WORK LOCATIONS / EMERGENCY CONTACT INFORMATION:

If information is located in field books, work plan, or elsewhere, ensure inspection team is aware and can readily locate.

Mobile phone or other means of contacting emergency personnel must be on site prior to starting inspection.

List complete location information for work in case of need for emergency response. List multiple if required.

Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Blatnik Bridge	535 and 35	535	Duluth, MN

Nearest Hospital Location: St. Marys Hospital, Duluth, MN 55805

Nearest Police / Fire Phone Numbers: 911

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Assess Site Conditions	**Weather Conditions:**		
	Rain, lightening, extreme temp. or wind, ice, other	Check forecast to be aware of possible inclement weather. Wait for improved conditions (at least 30 minutes after last lightening strike) or limit access to structure. Ensure inspection team is properly clothed and equipped (cold weather clothes, rain gear, etc.)	
	Traffic Conditions:		
	Vehicular traffic	Avoid high volume, high speed areas under construction or otherwise temporarily impeded (accidents, etc.) Wear proper reflective clothing and stay alert and vigilant. Coordinate with local authorities and inform them of our presence. Coordinate with Safety Signs for flagging and lane closure. Park vehicle near lift vehicle.	
	Rail traffic	Coordinate with proper jurisdiction if necessary, and arrange for flagman if required.	
	Boat traffic	Coordinate with proper jurisdiction if necessary, and stay alert for boat traffic and floating debris.	
Access Site	**Vehicular Traffic:**		
	Traffic at site	Park vehicle in safe location 10 foot from roadway edge, or off of roadway when possible.	
	Obstructions:		
	Obstructions (fences, retaining walls, vegetation, water, etc.)	Review previous inspection report, bridge file, and plans prior to inspection. Survey area for safest point of entry.	
	Traffic Control:		
	Traffic control setup	Traffic control should be setup in accordance with jurisdiction standard specifications (State/City/County etc.) or MUTCD. If roadway constraints do not allow for standard setup, competent person(s) should design proper traffic control.	
	Work zone check (traffic control)	Drive through work zone to ensure compliance with work zone standards (proper signage, configuration, etc.). Ensure traffic is flowing through work zone, and not encroaching on work zone.	
Inspection	**General Inspection:**		
	Insects, rodents, reptiles, other animals, poison ivy/oak, sunburn	Perform visual inspection of site prior to beginning work. Contact animal control or client if needed. Use wasp/hornet killer as needed. Wear proper PPE. Wear insect repellent clothing and sunscreen.	
	Sharp objects (rust, galvanizing drips, bolts, edges of plates, angles, etc.)	Visually inspect site for dangers. Wear proper PPE.	
	Slips, trips, and falls	Identify and avoid hazards if possible, guardrails, barriers, steep embankments, grade changes, etc. Wear proper PPE.	
	Vehicular Traffic:		
	Crossing lanes of traffic	Do not attempt to cross lanes of traffic in high volume conditions, low visibility condition, or high speed conditions. Do not cross traffic if traffic can not see you.	
	Traffic encroaching on work zone	Observe erratic drivers and avoid. Position yourself in safe place out of way of traffic when possible (behind guardrail or barrier, well off the road, etc.)	
	Aerial Lifts: * Ensure all team members are properly trained and qualified to operate lift.		
	Fall from height greater than 6 feet	Wear fall protection. Follow Collins fall protection and rescue plan. Report any incidents to team leader immediately.	
	Overhead hazards (electrical lines, bridge beams, etc.). Aerial lifts over water: Proper PPE including PFD, Marine Radio	Visually inspect site for dangers prior to entering lift. Wear proper PPE. Stay a least 10 feet from power lines at all times.	
	Over/Near Water	Wear proper PPE including PFD. Marine Radio to be at site. Throwable life ring to be on site.	

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS (Continued)

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Inspection (continued)	Wading		
	Enter water (slips /falls)	Visually inspect site prior to entering water. Survey area around bridge for best point of entry. Probe ahead of path with rod as entering. All team members aware of inspection POA. When working adjacent to water, you must wear a Personal Flotation Device.	
	Wade inspection / boat traffic / fast current	Stay alert for boat traffic, floating debris and swift currents. Probe ahead of path with rod when moving.	
	Exit water (slips/falls)	All team members assist each other when exiting the water.	
	UAV Concerns	Review and follow operations manual and use radios to communicate with operators to ensure public safety	
	Environmental Concerns	Stay alert for environmental factors.	
Post Inspection	General		
	Health and safety of inspector after inspection	Check inspectors health/condition after inspection. Inform the Team Leader of any inspection related injuries.	
	Work zone break down / vehicular traffic	Follow standards for work zone breakdown. Use proper MOT devices, vehicle with warning lights as needed to breakdown closure in reverse order.	

By signing this JSA, you confirm that each listed hazard has been reviewed during the safety briefing and you fully understand the work and safety procedures that can be utilized to mitigate these potential hazards. Inspectors are to report any physical problems before, during, or after the inspection. All incidents are to be reported to team leader as soon as possible.
Team leader shall complete an incident report and submit to Structural Inspection Program Manager and their respective Regional Manager.

Name / Signature / Date

Team Leader: ____________________ Inspector: ____________________

Inspector: ____________________ Inspector: ____________________

Inspector: ____________________ Inspector: ____________________

Unmanned Aerial System Bridge Inspection Study Phase II

Bridge 5767 Fieldwork

Investigation and Safety Plan

4/01/16

Prepared for:

MINNESOTA DEPARTMENT OF TRANSPORTATION

Prepared by:

COLLINS ENGINEERS INC.

1599 Selby Avenue
St. Paul, MN 55104
651.646.8502 • www.collinsengr.com

PROJECT SUMMARY

Project: Unmanned Aerial System Bridge Inspection Demonstration Project Phase II

Purpose of Project: The overall goal of the Unmanned Aerial System (UAS) Bridge Inspection Demonstration Project is to study the effectiveness of UAS technology when applied to bridge safety inspections.

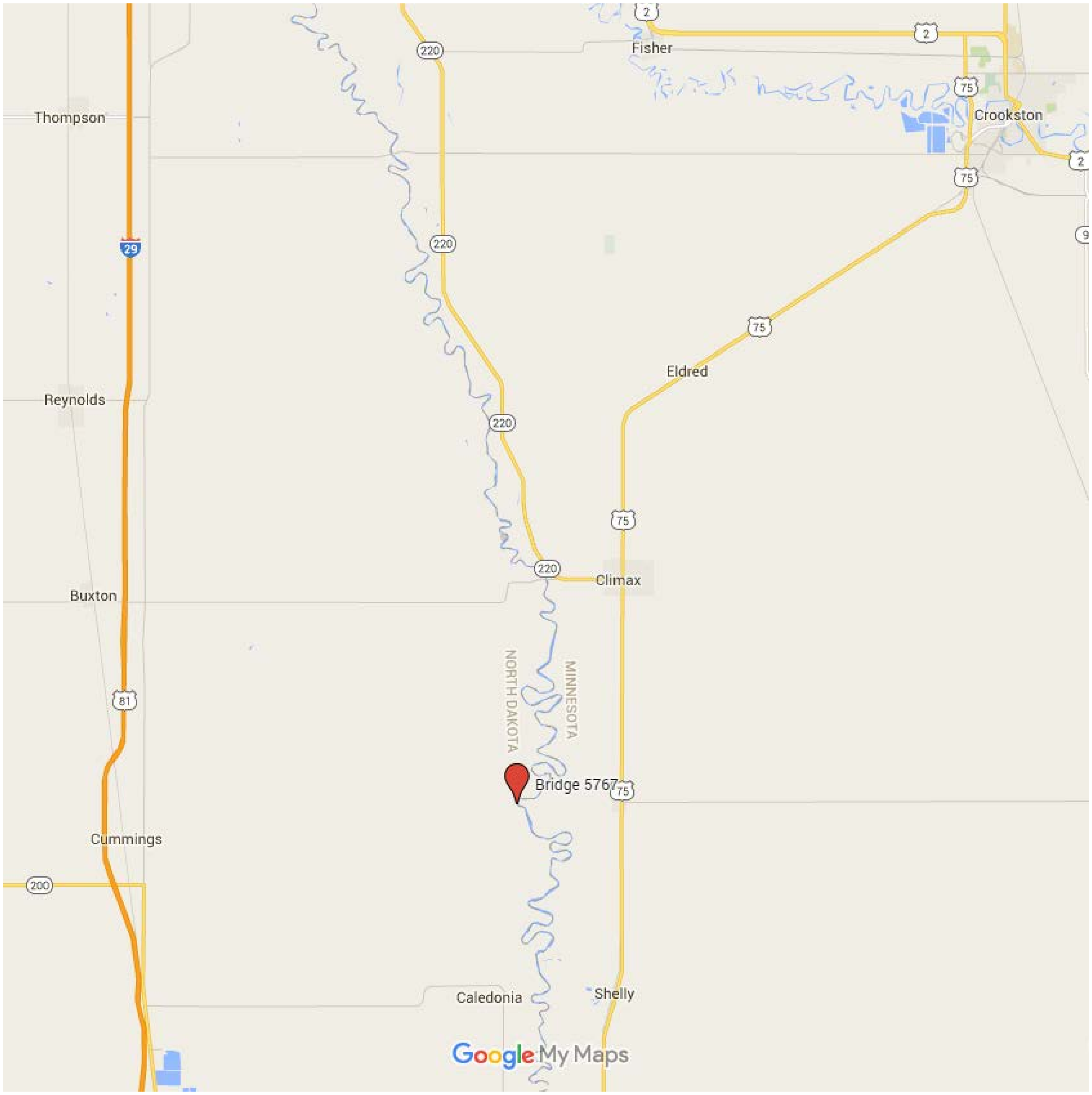
Field Team:

Jennifer Zink - MnDOT Project Manager
Barritt Lovelace – Collins Engineers - Project Manager, Quality Mangement
Mark Stern – Collins Engineers - UAS Pilot in Command
Dan Stong – RDO - UAS Expert
Joe Fishbein, MnDOT
Scott Thiesen, MnDOT
Rodney Carter, MnDOT

Field Date(s): April 20th-22nd, 2016, Working Hours 7:00 am – 5 pm

Project Location: Bridge 5767, CSAH 1 over the Red River, Nielsville, MN
Bridge Owner: Polk County

Map: Google Map of Bridge Site
https://www.google.com/maps/d/edit?mid=zWY1TJfvKcUc.kFQy6yKDvTQc&usp=sharing



Overall Bridge Location Map

1.0 INTRODUCTION

1.1 Project Overview

Increasing bridge maintenance and inspection costs are a concern for existing bridges in Minnesota. These additional costs can be minimized and the quality of inspections can be improved by utilizing Unmanned Aerial Systems (UAS). In the summer of 2015, MnDOT performed a Phase I study to evaluate the use of UAS for bridge inspections and the resulting study was published by the MnDOT Research Office. Based on the conclusions and recommendations of the first study, the overall goal of this Phase II contract is to further evaluate the effectiveness of UAS as it applies to Bridge Safety Inspections. This project will involve utilizing UAS to evaluate four structures to determine their effectiveness as a tool for bridge safety inspections. The structure types include a steel box girder, a steel culvert, a steel high truss and a steel open spandrel arch bridge. The Sensefly eXom, an inspection specific UAS, will be utilized to conduct the fieldwork. The study will culminate in a report detailing newer technology that is specific to inspection, a cost comparison to traditional access methods, and advantages and disadvantages of using the UAS during an actual inspection. The project will also include the development of a UAS best practices document based on the results of the study.

2.0 INVESTIGATION PLAN

The following describes the inspection plan for the Nielsville Bridge. The location, structure description, access methods, investigation methods and a site specific safety analysis are detailed below.

2.1 Bridge 5767 – Nielsville Bridge

2.1.1 Location

Bridge 5767 is located in just west of Nielsville, MN. The bridge carries CSAH 1 over the Red River. The bridge is owned by Polk County.

2.1.2 Structure Description

Bridge 5767 is a 2 span 362 foot long steel high truss. The bridge was constructed in 1939. The bridge was closed in September of 2015 due to deck deterioration. The inventory and inspection report can be found in Appendix B.

2.1.3 Access Methods

The bridge will be accessed from both the river banks and from the top of deck and a snooper will be used to access bridge components. Each fascia of the bridge will be flown from one end to the other to investigate the sides of the bridge. The bridge will also be flown from underneath to investigate the underside of deck, and substructures.. The top of the bridge will be flown to investigate the top of the truss and will be flown inside the truss to evaluate the top of deck. The UAS will be flown from the top of deck since the bridge is closed to traffic.

The UAS will be launched and flown from locations that are within the limits of the normal MnDOT inspection which generally includes areas immediately under the bridge and adjacent to the bridge. The UAS will not be flown from private property at any time.

2.1.4 Investigation Methods

The bridge will be inspected with the use of UAS technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAS. Any additional deficiencies discovered will be noted as well. The main focus of this effort is to study the effectiveness of the thermal camera in detecting concrete delaminations. The deck is delaminated and the UAS's thermal camera will be used to map the delaminations by flying over the deck and taking video and still images. Chain dragging of the deck will be performed and a handheld thermal camera will be utilized in an effort to correlate the data. A deck delamination memo for bridge 5767 and a deck delamination spreadsheet can be found in Appendix E. Photos will be taken of the entire bridge for creation of a 3D model using PIX4D software.

2.1.5 Site Specific Safety and Privacy

2.1.5.1 Permission from the nearby Nielsville Airport was obtained from the airport manager. Documentation can be found in Appendix D.

2.1.5.2 A job hazard analysis and a high work plan have been prepared and will be utilized to facilitate daily site safety briefings. Both documents can be found in Appendix A.

2.1.5.3 The bridge is currently closed with no traffic. The UAS will be flown in accordance with Collins Engineers FAA Section 333 Exemption and the FAA blanket Certificate of Authorization both of which can be found in Appendix C. The UAS will be flown such that it is never directly overhead the public. The inspection team will wear the proper personal protection equipment at all times including hard hats, safety glasses, reflective vests and fall protection equipment.

2.1.5.4 Bridge 5767 is located is a rural area and is currently closed. Privacy is not expected to be an issue but efforts will be made to not include the public in any photos or video taken during the fieldwork.

Respectfully Submitted,
COLLINS ENGINEERS, INC.

Barritt Lovelace, P.E., Regional Manager

Appendix A

Job Hazard Analysis

MnDOT High Work Plan

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION

Submit to Project Manager / Supervisor for approval prior to commencing work if necessary.

PROJECT INFORMATION:

Collins Project Number:	9336	Date:	3/24/2016
Client:	MnDOT	Prepared By:	Barritt Lovelace
Inspection Team Leader:	Jennifer Zink, Barritt Lovelace	For Date(s):	April 20th-22nd, 2016
General Work Location:	Bridge 5767, Nielsville, MN	Expected Work Duration:	1-3 days

REQUIRED SAFETY EQUIPMENT FOR INSPECTION CHECK LIST:

(Check if in Possession; obtain all applicable and required equipment prior to commencing work)

Personal Protective Equipment (PPE)		General Equipment		First Aid / Other:	
Hard Hat:	X	Project Work Plan:	X	First Aid Kit:	X
Safety Glasses:	X	GPS/Atlas/Maps:	X	Sunscreen:	X
Steel Toe Boots:	X	Harness:	X	Insect Repellent:	
Gloves:	X	Stress Release Straps for Harness:	X	Drinking Water:	X
Hearing Protection:		Lanyards:	X	Strobe Lights:	
Reflective Vests:	X	Tethers for Climbing Tools:		Two-Way Radios:	X
Reflective Pants (night work):		Personal Floatation Device:		Mobile Phone:	X
Rope Access Equipment:		:		:	
:		:		:	

WORK LOCATIONS / EMERGENCY CONTACT INFORMATION:

If information is located in field books, work plan, or elsewhere, ensure inspection team is aware and can readily locate.

Mobile phone or other means of contacting emergency personnel must be on site prior to starting inspection.

List complete location information for work in case of need for emergency response. List multiple if required.

Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Bridge 5767	TH 75	CSAH 1	Nielsville, MN

Nearest Hospital Location: t. Francis Hospital, Crookston, MN 5671

Nearest Police / Fire Phone Numbers: 911

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Assess Site Conditions	**Weather Conditions:**		
	Rain, lightening, extreme temp. or wind, ice, other	Check forecast to be aware of possible inclement weather. Wait for improved conditions (at least 30 minutes after last lightening strike) or limit access to structure. Ensure inspection team is properly clothed and equipped (cold weather clothes, rain gear, etc.)	
	Traffic Conditions:		
	Vehicular traffic	Avoid high volume, high speed areas under construction or otherwise temporarily impeded (accidents, etc.) Wear proper reflective clothing and stay alert and vigilant. Coordinate with local authorities and inform them of our presence. Coordinate with Safety Signs for flagging and lane closure. Park vehicle near lift vehicle.	

	Rail traffic	Coordinate with proper jurisdiction if necessary, and arrange for flagman if required.	
	Boat traffic	Coordinate with proper jurisdiction if necessary, and stay alert for boat traffic and floating debris.	
Access Site	Vehicular Traffic:		
	Traffic at site	Park vehicle in safe location 10 foot from roadway edge, or off of roadway when possible.	
	Obstructions:		
	Obstructions (fences, retaining walls, vegetation, water, etc.)	Review previous inspection report, bridge file, and plans prior to inspection. Survey area for safest point of entry.	
	Traffic Control:		
	Traffic control setup	Traffic control should be setup in accordance with jurisdiction standard specifications (State/City/County etc.) or MUTCD. If roadway constraints do not allow for standard setup, competent person(s) should design proper traffic control.	
	Work zone check (traffic control)	Drive through work zone to ensure compliance with work zone standards (proper signage, configuration, etc.). Ensure traffic is flowing through work zone, and not encroaching on work zone.	
Inspection	General Inspection:		
	Insects, rodents, reptiles, other animals, poison ivy/oak, sunburn	Perform visual inspection of site prior to beginning work. Contact animal control or client if needed. Use wasp/hornet killer as needed. Wear proper PPE. Wear insect repellent clothing and sunscreen.	
	Sharp objects (rust, galvanizing drips, bolts, edges of plates, angles, etc.)	Visually inspect site for dangers. Wear proper PPE.	
	Slips, trips, and falls	Identify and avoid hazards if possible, guardrails, barriers, steep embankments, grade changes, etc. Wear proper PPE.	
	Vehicular Traffic:		
	Crossing lanes of traffic	Do not attempt to cross lanes of traffic in high volume conditions, low visibility condition, or high speed conditions. Do not cross traffic if traffic can not see you.	
	Traffic encroaching on work zone	Observe erratic drivers and avoid. Position yourself in safe place out of way of traffic when possible (behind guardrail or barrier, well off the road, etc.)	
	Aerial Lifts: * Ensure all team members are properly trained and qualified to operate lift.		
	Fall from height greater than 6 feet	Wear fall protection. Follow Collins fall protection and rescue plan. Report any incidents to team leader immediately.	
	Overhead hazards (electrical lines, bridge beams, etc.). Aerial lifts over water: Proper PPE including PFD, Marine Radio	Visually inspect site for dangers prior to entering lift. Wear proper PPE. Stay a least 10 feet from power lines at all times.	
	Over/Near Water	Wear proper PPE including PFD. Marine Radio to be at site. Throwable life ring to be on site.	

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS (Continued)

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Inspection (continued)	Wading		
	Enter water (slips /falls)	Visually inspect site prior to entering water. Survey area around bridge for best point of entry. Probe ahead of path with rod as entering. All team members aware of inspection POA. When working adjacent to water, you must wear a Personal Flotation Device.	
	Wade inspection / boat traffic / fast current	Stay alert for boat traffic, floating debris and swift currents. Probe ahead of path with rod when moving.	
	Exit water (slips/falls)	All team members assist each other when exiting the water.	
	UAV Concerns	Review and follow operations manual and use radios to communicate with operators to ensure public safety	
	Environmental Concerns	Stay alert for environmental factors.	

Post Inspection	**General**		
	Health and safety of inspector after inspection	Check inspectors health/condition after inspection. Inform the Team Leader of any inspection related injuries.	
	Work zone break down / vehicular traffic	Follow standards for work zone breakdown. Use proper MOT devices, vehicle with warning lights as needed to breakdown closure in reverse order.	

By signing this JSA, you confirm that each listed hazard has been reviewed during the safety briefing and you fully understand the work and safety procedures that can be utilized to mitigate these potential hazards. Inspectors are to report any physical problems before, during, or after the inspection. All incidents are to be reported to team leader as soon as possible.
Team leader shall complete an incident report and submit to Structural Inspection Program Manager and their respective Regional Manager.

Name / Signature / Date

Team Leader: ______________________ Inspector: ______________________

Inspector: ______________________ Inspector: ______________________

Inspector: ______________________ Inspector: ______________________

Minnesota Department of Transportation Bridge High Work Plan (HWP)

Project Information

Bridge Number:	5767	***Location:***	CSAH 1 over the Red River in Polk Co.
GPS Coordinates – X:	47°31’38.15” N	***GPS Coordinates - Y:***	96°52’13.16”W
Activity:	Inspection	***Job Description:***	Bridge Inspection Performed with a A-62 & Drone
Traffic Control Layout:	Bridge Closed	***Height Working At:***	25’

Crew Members	***Work Site Location***	***HAR Training?***	***First Aid Training?***
Jennifer Zink	CSAH 6646 over red river of the north	☒Yes ☐No	☒Yes ☐No
Rodney Carter	CSAH 6646 over red river of the north	☒Yes ☐No	☒Yes ☐No
Scott Theisen	CSAH 6646 over red river of the north	☒Yes ☐No	☒Yes ☐No
Barritt Lovelace	CSAH 6646 over red river of the north	☒Yes ☐No	☒Yes ☐No
		☐Yes ☐No	☐Yes ☐No
		☐Yes ☐No	☐Yes ☐No
		☐Yes ☐No	☐Yes ☐No
		☐Yes ☐No	☐Yes ☐No

Rescue Plan Basics

Before the Work Begins

- Ensure training is up to date
- Perform equipment inspection
  - Harness, lanyard, trauma straps, rescue equipment, elevated work equipment, PPE
- Complete High Work Plan
  - Identify hazards and means of rescue
- Contact local emergency services
- Identify local equipment available for rescue
- Identify rescue equipment needed

At Fall Arrest

- See Rescue Flow Chart on Page 3
  - Call 911, MN Duty Officer
    - Request technical rescue
    - Determine response time
  - Contact local emergency services if needed
  - Deploy trauma straps
  - Determine means of rescue
  - Employ means of rescue

Post-Fall Rescue

- Provide suspension trauma first aid
  - Lower worker until toes touch and then gradually continue lowering the worker down until their feet are on the ground
  - Keep the worker upright
- Provide general first aid as needed until emergency services arrive

Rescue Considerations

Identify local emergency services (list below):	***Full time or volunteer?***	***Rope Rescue?***	***Elevated Rescue?***	***Confined Space Rescue?***	***Response Time (min)***	***Contact Information***
MN Duty Officer	☒Full Time ☐Volunteer	☒Yes ☐No	☒Yes ☐No	☒Yes ☐No		651-649-5451 or 1-800-422-0798
Polk Co Sheriff	☒Full Time ☐Volunteer	☐Yes ☒No	☐Yes ☒No	☐Yes ☒No		911/218-281-0431
Crookston Fire & Rescue	☒Full Time ☐Volunteer	☒Yes ☐No	☒Yes ☐No	☒Yes ☐No		Chief Tim Froeber Cell 218-289-1749, Non Emer. 218-281-4584
East Grand Forks, MN Fire & Rescue	☒Full Time ☐Volunteer	☒Yes ☐No	☒Yes ☐No	☒Yes ☐No		Chief Gary Larson Non Emer. #218-773-240

Identify nearest Truck Station(s):	***List available rescue equipment at the Truck Station:***	***Response Time (min)***	***Contact Information***
N/A			
Identify nearest Contractor/Other Industry:	***List available rescue equipment at the Contractor or Other Industry Site:***	***Response Time (min)***	***Contact Information***

?			

Hazard Analysis	Potential Accidents or Hazards	Preventive Measure
Fall hazard present?	☒ Yes ☐ No	Fall Protection
Site conditions below high work level	☒ Water ☒ Uneven Slope ☐ Railroad ☐ Traffic ☐ Riprap ☐ Bridge Elements ☐ Construction/Other Workers ☐ Other:	
Site conditions at high work level	☐ Traffic ☐ Uneven Slope ☐ Inadequate sight distance ☐ Limited working space ☒ Low bridge rail height (<42 inches) ☐ Surface Conditions ☐ Confined Space ☐ Other:	
Work Environment (weather, lighting, space)		
Other Considerations		

High Angle Rescue Options and Equipment Plan

Rescue Options*		Equipment		
		On Worker	In Snooper Basket	In Snooper Vehicle
1	Assisted ascent to basket with 4 to 1 and pick pole	Rescue harness, trauma straps	Pick Pole, Aztek Elite 4 to 1. Identify anchorage point for 4 to 1.	
2	Self ascent to basket		Ascenders and 20’ rescue rope. Attach rope to anchorage point in basket. Attach ascenders to rope.	
3	Self descent to ground		1 Petzl I’D self-braking Descender and 20’ Rescue Rope . Atttach rope to anchorage point in basket.	
4	Descent from deck to faciliate team rescue			Rope Bag (rope),1 Petzl I’D self-braking Descender, Pick-Off Strap and Scissors. Need to locate appropriate anchorage point ahead of time.
5	Descent from basket to faciliate team rescue		1 Petzl I’D self-braking Descender and 20’ Rescue Rope . Attach rope to anchorage point in basket.	
6	Wait for qualified EMS			

***Refer to Rescue Flow Chart on Next Page**

Make contact with the local emergency services PRIOR to commencing the high work.

Information for 911 and MN Duty Officer

- Name of caller, agency and contact information
- Date, time and location (GPS coordinates) of incident
- Who else has been notified
- Incident details and current situation
- Number of personnel involved and current status
- Type of assistance needed (technical rescue: ropes, confined space, elevated, etc.)

Incident on a Bridge

Worker is suspended from snooper basket

1. **Call 911**
   a. Determine rescue capabilities and response time.
2. **Call MN Duty Officer 651-649-5451 or 1-800-422-0798**
   a. Request Technical Rescue. Determine response time.

Is worker incapacitated?

Yes →

Is a second snooper or other equipment available for rescue? Yes → **Recover the worker with the second snooper or other available equipment**

No → Is the primary snooper operational? Yes → **Recover the worker with the primary**

No → Can the worker be safely lowered to the ground? Yes → **If safe to do so, use High Angle Rescue Equipment to recover the worker to the**

No → Is ascent to basket with pick pole and 4 to 1 feasible? Yes → **Recover the worker to the basket**

No → **Wait for qualified Emergency Services or facilitate team rescue if safe to do so**

No →

Deploy trauma

Is a second snooper or other equipment available for rescue? Yes → **Recover the worker with the second snooper or other available equipment**

No → Is the primary snooper operational? Yes → **Recover the worker with the primary snooper**

No → Is ascent to basket (self or with pick pole) feasible? Yes → **Facilitate ascent to basket**

No → Is self descent to ground feasible? Yes → **Faciliate self descent to ground**

No → **Wait for qualified Emergency Services or facilitate team rescue if safe**

***NOTE**: If qualified emergency services can respond within a reasonable time and the worker has deployed trauma straps, waiting for emergency services may be the best option. However, assessing the situation to determine the best equipment and/or means of rescue available to the crew will save valuable time when emergency services arrive.*

	Rescue Options	Equipment: Worker	Equipment: in Basket	Equipment: in Snooper
1	Assisted ascent to basket	Rescue harness and trauma straps	Pick pole, 4 to 1	
2	Self ascent to basket		ascenders, 20' rope	
3	Self descent to ground		descender, 20' rope	
4	Descent from deck to faciliate team rescue			rope/equipment bag, descender
5	Descent from basket to faciliate team rescue		descender, 20' rope	
6	Wait for qualified EMS			

Treat Suspension Trauma: Lower worker to tip toes and then gradually continue lowering until their feet are on the ground. Keep worker upright. Provide general first aid until emergency services arrive.

Jan 2016

Appendix B

Bridge Inventory and Inspection Reports

MINNESOTA DEPARTMENT OF TRANSPORTATION

UNKNOWN

ALL BRIDGE INSPECTIONS

1 BRIDGE INSPECTION

SORTED BY INSPECTION DATE

Individual Bridge(s) 5767

Report Type: Inventory and Inspection

MINNESOTA STRUCTURE INVENTORY REPORT

Bridge ID: 5767 **CSAH 1 over RED RIVER OF THE NORTH**

Date: 03/23/2016

GENERAL

Agency Br. No.	718
District	2
Maint. Area	
County	60 - POLK
City	
Township	HUBBARD
Desc. Loc.	2.5 MI W OF JCT TH 75
Sect., Twp., Range	26 - 147N - 49W
Latitude	47d 31m 37.61s
Longitude	96d 52m 16.18s
Custodian	COUNTY
Owner	COUNTY
Inspection By	POLK COUNTY
Year Built	1939
MN Year Remodeled	
FHWA Year Reconstructed	
Bridge Plan Location	CENTRAL
ABC Suitable	

STRUCTURE

Service On	HIGHWAY
Service Under	STREAM
Main Span Type	STEEL HIGH TRUSS
Main Span Detail	PARKER
Appr. Span Type	
Appr. Span Detail	
Skew	
Culvert Type	
Barrel Length	

Number of Spans

MAIN: 2 APPR: 0 TOTAL: 2

Main Span Length	177.0 ft
Structure Length	362.0 ft
Deck Width	26.0 ft
Deck Material	C-I-P CONCRETE
Wear Surf Type	MONOLITHIC CONC
Wear Surf Install Year	
Wear Course/Fill Depth	
Deck Membrane	NONE
Deck Rebars	NONE
Deck Rebars Install Year	1939
Structure Area	9,412 sq ft
Roadway Area	8,719 sq ft
Sidewalk Width - L/R	
Curb Height - L/R	
Rail Codes - L/R	02 02

ROADWAY

Bridge Match ID (TIS)	1
Roadway O/U Key	1-ON
Route Sys/Nbr	CSAH 1
Roadway Name or Description	CSAH 1
Roadway Function	MAINLINE
Roadway Type	2 WAY TRAF
Control Section (TH Only)	
Ref. Point	
Date Opened to Traffic	
Detour Length	10 mi.
Lanes	2 Lanes ON Bridge
ADT (YEAR)	259 (2008)
HCADT	
Functional Class.	RUR/MAJOR COLL

RDWY DIMENSIONS

If Divided	**NB-EB**	**SB-WB**
Roadway Width	24.1 ft	
Vertical Clearance	16.1 ft	
Max. Vert. Clear.	16.1 ft	
Horizontal Clear.		
Lateral Clr. - Lt/Rt		
Appr. Surface Width	30.0 ft	
Bridge Roadway Width	24.1 ft	
Median Width on Bridge		

MISC. BRIDGE DATA

Structure Flared	NO
Parallel Structure	NONE
Field Conn. ID	RIVETED
Cantilever ID	

Foundations

Abut.	CONC - FTG PILE
Pier	CONC - FTG PILE
Historic Status	NOT ELIGIBLE
On - Off System	ON

PAINT

Year Painted	1958
Pct. Unsound	60 %
Painted Area	
Primer Type	LEAD
Finish Type	PHENOLIC RESIN ALUM.

BRIDGE SIGNS

Posted Load	NOT REQUIRED
Traffic	NOT REQUIRED
Horizontal	OBJECT MARKERS
Vertical	NOT APPLICABLE

INSPECTION

Deficient Status	S.D.
Sufficiency Rating	41.7
Last Inspection Date	10-29-2015
Inspection Frequency	12
Inspector Name	POLK
Status	K-CLOSED

NBI CONDITION RATINGS

Deck	20 % UNSOUND	0
Superstructure		5
Substructure		4
Channel		5
Culvert		N

NBI APPRAISAL RATINGS

Structure Evaluation	4
Deck Geometry	5
Underclearances	N
Waterway Adequacy	4
Approach Alignment	4

SAFETY FEATURES

Bridge Railing	0-SUBSTANDARD
GR Transition	0-SUBSTANDARD
Appr. Guardrail	0-SUBSTANDARD
GR Termini	0-SUBSTANDARD

IN DEPTH INSP.

Frac. Critical	Y	24 mo	05/2015
Underwater	Y	60 mo	08/2012
Pinned Asbly.			
Spec. Feat.			

WATERWAY

Drainage Area	
Waterway Opening	14000 sq ft
Navigation Control	NO PRMT REQD
Pier Protection	NOT APPL
Nav. Vert./Horz. Clr.	
Nav. Vert. Lift Bridge Clear.	
MN Scour Code	I-LOW RISK
Scour Evaluation Year	1991

CAPACITY RATINGS

Design Load	UNKN
Operating Rating	HS 25.20
Inventory Rating	HS 15.20
Posting	
Rating Date	01-09-2009

Overweight Permit Codes

A: N B: N C: N

03/23/2016

MINNESOTA BRIDGE INSPECTION REPORT

Inspected by: POLK COUNTY

BRIDGE 5767 **CSAH 1 OVER RED RIVER OF THE NORTH** **INSP. DATE: 10-29-2015**

County: POLK
City:
Township: HUBBARD
Section: 26 Township: 147N Range: 49W
Span Type: STEEL HIGH TRUSS
NBI Deck: 0 Super: 5 Sub: 4 Chan: 5 Culv: N

Location: 2.5 MI W OF JCT TH 75
Route: CSAH 1 Ref. Pt.: 000+00.000
Control Section: Maint. Area:
Local Agency Bridge Nbr: 718

Length: 362.0 ft
Deck Width: 26.0 ft
Rdwy. Area / Pct. Unsnd: 8,719 sq ft 20 %
Paint Area / Pct. Unsnd: 60 %
Culvert : N/A

Open, Posted, Closed: CLOSED

Appraisal Ratings - Approach: 4 Waterway: 4
MN Scour Code: I-LOW RISK
Def. Stat: S.D. Suff. Rate: 41.7

Required Bridge Signs - Load Posting: NOT REQUIRED Traffic: NOT REQUIRED
Horizontal: OBJECT MARKERS Vertical: NOT APPLICABLE

ELEM NBR	ELEMENT NAME	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4
800	CRITICAL DEFS OR SAFETY HAZARDS	10-29-2015	1 EA	1	0	0	0

Notes: Bridge closed due to deck failure

12	REINFORCED CONCRETE DECK	10-29-2015	9,412 SF	8,471	0	941	0

Notes: Minor transverse cracking.
2013-2015: CS3 due to water saturation 3' (approximately) on either side of every floor beam due to deck leakage. Water saturation is causing deterioration of the floorbeams and stringers. Moved to CS4 because the area of deck cracking and saturation is approximately 20%.

510	*WEARING SURFACE*	10-29-2015	8,719 SF	6,539	0	2,180	0

Notes: Top of Concrete Deck with Uncoated Rebar Notes: Numerous transverse cracks. Deck is deteriorating at the edge of joints and should be patched. Spalls and patching more than 2% but less than 10% of deck area(09). Joints on west and east span require sealing. Moderate scaling in from curb 2-3' entire deck(2011). Patching required/existing patch failure(2012).
2013: There are transverse cracks over the floorbeams and map cracking throughout. Patches are failing.
(14)Patching completed.
2015: Deck continues to deteriorate.
2015: Hole in deck has developed near ND approach. Bridge closed.

810	CONC WEAR SURF-CRACKING SEALING	10-29-2015	0 LF	0	0	0	0

Notes: Cracking throughout deck.
2013-2015: Transverse cracks over the floorbeams and map cracking throughout.

301	POURED SEAL JOINT	10-29-2015	335 LF	0	0	0	335

Notes: Joints should be sealed/patched concrete edge is breaking away. Joints sealed in 2004 and in fair condition. Bituminous material used for joint sealant has failed. Concrete continues to deteriorate. Steel exposed at west joint.
2013-2015: No change.

305	ASSEMBLY DECK JOINT	10-29-2015	26 LF	0	26	0	0

Notes: 1 sliding plate. Joint is leaking and moderate surface corrosion on top and bottom sliding plate(2011).
2013-2015: No change.

330	METAL BRIDGE RAILING	10-29-2015	725 LF	3	699	23	0

Notes: Railing bent in 6in. at center of bridge, west truss, south side. Rail should be cut to prevent further movement of concrete end posts(2010). End of rail cut in 2011 to prevent additional damage to concrete rail post. Railing bent in 4" in center of bridge north side(2011). 2013: No change. Measurements from end of rail to concrete rail- SE 3 1/2", NE 3 1/2", SW 9 1/2", NW 10".
2014:concrete end post and metal rail:SE-2 1/2",NE-3 1/8",SW-9 1/2",NW-10"
2015: No significant change.

515	*STEEL PROTECTIVE COATING*	10-29-2015	999 SF	999	0	0	0

Notes: [2016] Migrator assumed CS1 and a quantity of 999 SF.

331	REINFORCED CONC BRIDGE RAILING	10-29-2015	4 LF	0	0	0	4

Notes: All four concrete end posts are spalled and exposing rebar and in a very poor condition. Patching required.
2013-2015: No change. End posts are damaged due to bridge movement. The railings have been cut to prevent further damage.

822	BITUMINOUS APPROACH ROADWAY	10-29-2015	4 EA	1	2	1	0

Notes: The East approach has been replaced since the last Fracture Critical Inspection (2009). The West approach has cracking up to 1/2" wide in the overlay(2011). 2013: The west approach panel has 4" of settling on the eastbound side.
(14)1" road settlement at west approach.
2015: The west approach has significant settling (4") along the entire width. The east approach has minor settling.

Approaches require patching(05). Road has settled 6" 100' west of approach(2008) - repaired 2010.

113	STEEL STRINGER	10-29-2015	1,345 LF	0	1,245	100	0

Notes: Paint chalky on majority of stringers. Fascia stringers have moderate surface corrosion(2011). At most fascia stringer connections to floorbeams, extensive flaking rust 6" to 1' of the web(2011).
2013: 1299 feet in CS3 due to surface rust and flaking paint.
2015: Approximately 1' of CS4 at each end of most stringers at the floorbeam connections - Photo 1.

515	*STEEL PROTECTIVE COATING*	10-29-2015	999 SF	0	0	0	999

Notes: [2016] Migrator assumed quantity of 999 SF and estimated the condition states.

120	STEEL TRUSS	10-29-2015	705 LF	0	705	0	0

Notes: Bottom Chord Notes: Active corrosion - flaking present. Debris has caused minor damage throughout lower cord.
2013: Paint failure and surface corrosion along the entire length, but no significant pack rust or section loss. Minor impact damage from debris removal on upstream chord.
2015: No significant change.

Top Chord Notes: Minor active corrosion. Paint system has failed on upper members.
2013: Localized failing paint and surface corrosion, but no significant pack rust or section loss. Areas of minor impact damage due to debris removal.
2015: No significant change.

Fracture Critical Smart Flag Notes:

Pack Rust Notes: Pack rust is forming between horizontal gusset plate and the floorbeams, but not causing significant stress on elements(2011).
2013-2015: No change.

515	*STEEL PROTECTIVE COATING*	10-29-2015	999 SF	0	0	0	999

Notes: [2016] Migrator assumed quantity of 999 SF and estimated the condition states.

152	STEEL FLOORBEAM	10-29-2015	417 LF	0	160	257	0

Notes: Paint chalky. Top flange cond. 4. Extensive flaking rust on top and bottom flanges and 1' of the webs at the gusset plate connections on all floorbeams, worst case is on floorbeams 0,1,2 of the west span(2011). Rest of floorbeam webs have moderate surface rust(2011).
2013: Floorbeams 4, 5 and 6 in Span 1 and Floorbeams 1, 2 and 6 in Span 2 have section loss (CS4) the entire length. Floorbeams 1 and 2 in Span 1 and Floorbeam 5 in Span 2 have scattered areas of section loss (CS4). The remainder are in CS3. Cross sectional losses do not exceed 5%.
2015: 8 floorbeams have section loss on the bottom flange and bottom of the web for their entire length. Three others have section loss on 6 - 10 feet on the ends (Photos 2-4). However, total cross sectional loss does not exceed 5%.

515	*STEEL PROTECTIVE COATING*	10-29-2015	999 SF	0	0	0	999

Notes: [2016] Migrator assumed quantity of 999 SF and estimated the condition states.

162	STEEL GUSSET PLATE	10-29-2015	56 EA	0	56	0	0

Notes: Minor deterioration, surface corrosion and freckled rust(09). 2011 - surface corrosion and paint failure.
2013-2015: No significant change.

Gusset Plate Distortion Notes: 2011: West span gusset plate distortion measurements: L1S(1/16" Ext GP Top Free Edge), L5S(1" EXT GP W Free Edge), L6S(1/2" Ext GP Top Free Edge) and east span gusset plates L1N(1/8" EXT GP W Edge), L5N(1/8" EXT GP Top Free Edge) are bowed. anything over 1/8" bowing is from impact damage due to flood debris.
2013: No significant change.

515	*STEEL PROTECTIVE COATING*	10-29-2015	999 SF	0	0	0	999

Notes: [2016] Migrator assumed quantity of 999 SF and estimated the condition states.

210	REINFORCED CONCRETE PIER WALL	10-29-2015	26 LF	0	0	26	0

Notes: Debris at center pier should be removed(2009,2010). Pier appears to be out of alignment (lateral W-E movement), apparently by expansion bearings tilted beyond design limits(2011).
2013-2015: Flood debris has accumulated on the upstream side. It appears that the entire bridge is moving to the west, causing the bearings to tip; however, annual surveying would be required to determine which part of the substructure is moving.

215	REINFORCED CONCRETE ABUTMENT	10-29-2015	92 LF	0	0	92	0
Notes:	[2016] Migrator added 40 LF to abutment quantity to account for wingwalls (CS1:0 CS2:0 CS3:40 CS4:0). Debris deposited up to abutment. South end exposed piles due to scouring (east). Erosion at se corner of east abutment exposing footings - (07)continues. Abutments appear to be moving towards river. Movement of the piers and/or abutments causing bearings to tilt. 2011 - Both abutments tipped back 3/8" over a 4' level. SW bearing pedalstal is exposed due to undermining. Approximately 1' is exposed and extends 1' under footing. Undermining evident sw bearing ped(2012). 2013: Flood sediment (aggredation) has filled in the erosion at the East Abutment. The undermining on the SW bearing pedestal is still present. One or both abutments are moving; however, annual surveying would be required to determine which part of the substructure is moving. 2015: Erosion is again present at the west abutment. Undermining of the southwest bearing seat extends more than 3'. There are 3' of spalls on the						
234	REINFORCED CONCRETE PIER CAP	10-29-2015	26 LF	0	26	0	0
Notes:	Minor cracking and spalling(09).. 2013-2015: No change.						
311	EXPANSION BEARING	10-29-2015	4 EA	0	0	0	4
Notes:	Do not appear to be working (rocker bearings). Are severely tilted and should be monitored. 2013: Bearings are severly tilted. Bearing tilt is slightly less or the same as in 2011. 2015: No change. The east bearings are tilted more severely to the west than the west bearings.						
313	FIXED BEARING	10-29-2015	4 EA	0	4	0	0
Notes:	Not technically fixed (at abutments). Minor surface rust. Bearings at the abutments need to be cleaned(09). Extensive debris on west abutment bearing(2011). 2013: No change. Distance from bearings to abutment wall: NE-21", NW 24.25", SE-21.75", SW-25". Lead plate is sliding out from under the SW bearing. 2015: No difference in condition. Distance from bearings to abutment wall: NE-20", NW 24", SE-17.5", SW-24".						
855	SECONDARY MEMBERS (SUPER)	10-29-2015	1 EA	0	0	1	0
Notes:	Currently most of the lateral bracing under the bridge has been damaged by flooding(09). 2013: There is impact damage to several of the upper horizontal braces. 2013-2015: No significant change.						
880	IMPACT DAMAGE	10-29-2015	1 EA	0	1	0	0
Notes:	Impact damage has occurred at several locations but structural integrity of the bridge has not been significantly reduced(09). 2013: Several of the upper wind braces and both portal braces have been struck by high loads and most of the lower lateral bracing has flood impact damage. 2015: It appears that there is further impact damage to the west portal brace. There are several tears and areas of misalignment.						
881	STEEL SECTION LOSS	10-29-2015	1 EA	0	1	0	0
Notes:	Floorbeams and stringers have moderate section loss - mostly on top flange(09). 2013: Section loss on 10 of the 16 floorbeams. No cross sectional loss in excess of 5%. 2015: There is section loss on 11 of the floorbeams, 8 of which have CS4 the entire length. Still no cross sectional loss in excess of 5%.						
883	CONCRETE SHEAR CRACKING	10-29-2015	1 EA	1	0	0	0
Notes:							
884	SUBSTRUCTURE SETTLEMENT & MVMT	10-29-2015	1 EA	0	1	0	0
Notes:	Measuments taken due to substructure movement - see photos 2009 - NE-22 5/8, SW-25 1/2, NW-25 3/16, SE-19 1/4 2010 - NE-22 1/2, SW-25 3/8, NW-25 1/8, SE-18 15/16 2011 - NE-22 1/8, SW-25 5/8, NW-25, SE-18 3/4 2012 - NE-21 3/4, SW-25, NW-24 3/4, SE-18 3/8 2013 - NE-21.25", SW-24 5/8, NW-24.5", SE-17 15/16". 2014 - NE-20 1/8, SW-24 1/4, NW-23 7/8, SE-17 9/16 2015 - NE-20", SW-24". NW 24", SE-17.5"						
885	SCOUR	10-29-2015	1 EA	0	1	0	0

Notes: Additional action required. Scour evident at both abutments. Scour hole by the SW bearing pedalstal, exposing 1 SF of the underside of the footing(2011). Another scour hole directly below L6-L7 bay in east span. Structural analysis is not warranted at this time(2011). Riprap/fill required SW bearing ped corner(2012).
2013: Flood sediment (aggredation) has filled in the erosion on the East Abutment. The scour and undermining on the SW bearing pedestal is still present(14).
2015: Erosion is again present at the west abutment. Undermining of the southwest bearing seat extends more than 3'.

891	OTHER BRIDGE SIGNING	10-29-2015	1 EA	0	1	0	0

Notes: SE delineator twisted(2011).
2013: East delineators replaced.
2015: The southeast delineator has minor damage but is still legible.

892	SLOPES & SLOPE PROTECTION	10-29-2015	1 EA	0	1	0	0

Notes: Undermining at SE bearing pedestal - 3 to 5'hole(2010). Debris in truss and at piers(2009,2010). (08)Riprap placed at east abutment, south end. Ditch cleaned SW in 2010. Tree trimming required(2010). Flood debris east slope and sw(2011). Severe erosion due to scour east and west slopes(2011). Debris at SW corner(2012).
2013: Riprap installed late 2012 east abutment.
(14)Significant amount of debris built up on upstream side of pier. (14)Trees trimmed east side.
2015: There is debris build-up on both ends of the west abutment.

893	GUARDRAIL	10-29-2015	1 EA	0	0	0	1

Notes: 54 lf of guardrail installed on the North Dakota side(09). None on minnesota side. 2011- SW rail has impact damage where end treatment has broken away from the metal post and the bolt on first wooden post is turned out.
2013: Still no guardrail on east end. Southwest guardrail has been repaired.
2015: No significant change.

894	DECK & APPROACH DRAINAGE	10-29-2015	1 EA	0	1	0	0

Notes: Deck drains require cleaning(2011). Drain pipe bent between L5-L6 west span, north truss(2011). Bottom drain bracing member is bent between L2-L3 east span, north truss. Drains clean in 2012 but mud buildup on deck.
2013-2015: All deck drains are open.

895	SIDEWALK, CURB, & MEDIAN	10-29-2015	1 EA	0	1	0	0

Notes: Curb has moderate damage and deterioration at panel point locations(09).
2013-2015: No significant change.

899	MISCELLANEOUS ITEMS	10-29-2015	1 EA	0	1	0	0

Notes: This element is used to monitor debris that require removal. 2011 - debris buildup is significant at piers and abutments.
2013-2015: No change.

900	PROTECTED SPECIES	10-29-2015	1 EA	1	0	0	0

Notes: Use this element to track the presence of protected species living on this structure.

General Notes: *PHOTO NO. 718 BUILT IN 1939 STEEL HIGH TRUSS

FRACTURE CRITICAL INSPECTION COMPLETED BY MNDOT ON JULY 30, 1996, 7-13-2001, 6-13-2006, 9-13-2007, 5-18-2009 and 5/17/2011. HERE ARE SOME OF THE GENERAL COMMENTS:

1. ALL ROCKER BEARINGS APPEAR TO BE LOCKED.
2. NORTH AND SOUTH TRUSS - LOWER CHORD: SCATTERED PAINT FAILURE AND ACTIVE CORROSION IS PRESENT.
3. NORTH AND SOUTH TRUSS - LOWER CHORD PANEL POINTS: WEST BRIDGE, SOUTH TRUSS AT POINT L6, 2in. AWAY FROM THE GUSSET PLATE, THERE IS AN INDENTION ON THE EXTERIOR SIDE (FACIA) OF THE DIAGONAL (12in. LONG X 1.25in. IN DEPTH). WEST BRIDGE, SOUTH TRUSS AT POINT L4, THERE IS AN INDENTION IN THE GUSSET PLATE ON THE EXTERIOR SIDE (FACIA) OF THE PANEL POINT (8in. LONG X 1in. IN DEPTH). PAINT FAILURE.
4. NORTH AND SOUTH TRUSS - UPPER CHORD PANEL POINTS: PAINT SYSTEM CATEGORIZED AS CONDITION 2.
5. NORTH AND SOUTH TRUSS - FLOORBEAMS, DIAGONALS, AND VERTICALS: PAINT SYSTEM FOR THE FLOOR BEAMS CATEGORIZED AS CONDITION 3. ACTIVE CORROSION IS PRESENT. THE PAINT SYSTEM AND CORROSION OF THE DIAGONALS WOULD BE CATEGORIZED AS CONDITION 3. THE PAINT SYSTEM AND CORROSION OF THE VERTICALS WOULD BE CATEGORIZED AS CONDITION 2. WIND BRACING DAMAGED IN SEVERAL LOCATIONS. TRUSS IMPACT DAMAGE: EAST SPAN- NORTH TRUSS, L0-U1 DAMAGE 5in. ABOVE CURB NORTH TRUSS, U1-L2 DAMAGE 3in. AND 6in. ABOVE CURB SOUTH TRUSS, L3-U4 DAMAGE 2in. ABOVE CURB EAST AND WEST PORTAL DAMAGE WEST TRUSS- SOUTH TRUSS, LATERAL MEMBER DAMAGE SOUTH TRUSS, L5-U5 DAMAGE 6-7in ON INSIDE FLANGE SOUTH TRUSS, L6-U6 DAMAGE 5in ON OUTSIDE FLANGE WEST PORTAL DAMAGE. Underwater inspection-9/18/07 Underwater inspection completed September 18, 2007. General comments: Debris at south end along pier 1, light scaling along entire perimeter of pier, scour depression 1 foot deep by 4 feet at pier 1, vertical cracks up to 1/8 inch on

both faces of pier 1. Monitor timber debris buildup. Underwater 2012 - see report - moderate to heavy timber buildu

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MINNESOTA BRIDGE INSPECTION REPORT
OLD ELEMENT SYSTEM

Inspected by: POLK COUNTY

BRIDGE 5767 CSAH 1 OVER RED RIVER OF THE NORTH INSP. DATE: 10-29-2015

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
12	TOP OF CONCRETE DECK	2	10-29-2015	9,397 SF	0	0	0	9,397	0
			05-13-2015	9,397 SF	0	0	0	9,397	0

Notes: |Numerous transverse cracks. Deck is deteriorating at the edge of joints and should be patched. Spalls and patching more than 2% but less than 10% of deck area(09). Joints on west and east span require sealing. Moderate scaling in from curb 2-3' entire deck(2011). Patching required/existing patch failure(2012). 2013: There are transverse cracks over the floorbeams and map cracking throughout. Patches are failing.
(14)Patching completed.
2015: Deck continues to deteriorate.
2015: Hole in deck has developed near ND approach. Bridge closed.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
301	POURED DECK JOINT	2	10-29-2015	335 LF	0	0	335	N/A	N/A
			05-13-2015	335 LF	0	0	335	N/A	N/A

Notes: |Joints should be sealed/patched concrete edge is breaking away. Joints sealed in 2004 and in fair condition. Bituminous material used for joint sealant has failed. Concrete continues to deteriorate. Steel exposed at west joint.
2013-2015: No change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
303	ASSEMBLY DECK JOINT	2	10-29-2015	26 LF	0	26	0	N/A	N/A
			05-13-2015	26 LF	0	26	0	N/A	N/A

Notes: |1 sliding plate. Joint is leaking and moderate surface corrosion on top and bottom sliding plate(2011).
2013-2015: No change.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
320	CONC APPR SLAB-BITOL	2	10-29-2015	2 EA	1	0	1	0	N/A
			05-13-2015	2 EA	1	0	1	0	N/A

Notes: |The East approach has been replaced since the last Fracture Critical Inspection (2009). The West approach has cracking up to 1/2" wide in the overlay(2011). 2013: The west approach panel has 4" of settling on the eastbound side.
(14)1" road settlement at west approach.
2015: The west approach has significant settling (4") along the entire width. The east approach has minor settling. |

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
407	BITUMINOUS APPROACH	2	10-29-2015	2 EA	0	2	0	0	N/A

Notes: |Approaches require patching(05). Road has settled 6" 100' west of approach(2008) - repaired 2010.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
331	CONCRETE RAILING	2	10-29-2015	4 LF	0	0	0	4	N/A
			05-13-2015	4 LF	0	0	0	4	N/A

Notes: |All four concrete end posts are spalled and exposing rebar and in a very poor condition. Patching required.
2013-2015: No change. End posts are damaged due to bridge movement. The railings have been cut to prevent further damage.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
334	METAL RAIL-COATED	2	10-29-2015	725 LF	3	0	699	23	0
			05-13-2015	725 LF	3	0	699	23	0

Notes: |Railing bent in 6in. at center of bridge, west truss, south side. Rail should be cut to prevent further movement of concrete end posts(2010). End of rail cut in 2011 to prevent additional damage to concrete rail post. Railing bent in 4" in center of bridge north side(2011). 2013: No change. Measurements from end of rail to concrete rail- SE 3 1/2", NE 3 1/2", SW 9 1/2", NW 10".
2014:concrete end post and metal rail:SE-2 1/2",NE-3 1/8",SW-9 1/2",NW-10"
2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
113	PAINT STEEL STRINGER	2	10-29-2015	1,345 LF	0	0	1,245	100	0
			05-13-2015	1,345 LF	0	0	1,245	100	0

Notes: |Paint chalky on majority of stringers. Fascia stringers have moderate surface corrosion(2011). At most fascia stringer connections to floorbeams, extensive flaking rust 6" to 1' of the web(2011).
2013: 1299 feet in CS3 due to surface rust and flaking paint.
2015: Approximately 1' of CS4 at each end of most stringers at the floorbeam connections - Photo 1.|

MINNESOTA BRIDGE INSPECTION REPORT
OLD ELEMENT SYSTEM

03/23/2016

Inspected by: POLK COUNTY

BRIDGE 5767 CSAH 1 OVER RED RIVER OF THE NORTH INSP. DATE: 10-29-2015

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
121	P/STL THRU TRUSS/BOT	2	10-29-2015	705 LF	0	0	705	0	0
			05-13-2015	705 LF	0	0	705	0	0

Notes: |Active corrosion - flaking present. Debris has caused minor damage throughout lower cord.
2013: Paint failure and surface corrosion along the entire length, but no significant pack rust or section loss. Minor impact damage from debris removal on upstream chord.
2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
126	P/STL THRU TRUSS/TOP	2	10-29-2015	705 LF	0	0	705	0	0
			05-13-2015	705 LF	0	0	705	0	0

Notes: |Minor active corrosion. Paint system has failed on upper members.
2013: Localized failing paint and surface corrosion, but no significant pack rust or section loss. Areas of minor impact damage due to debris removal.
2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
152	PAINT STL FLOORBEAM	2	10-29-2015	417 LF	0	0	160	257	0
			05-13-2015	417 LF	0	0	160	257	0

Notes: |Paint chalky. Top flange cond. 4. Extensive flaking rust on top and bottom flanges and 1' of the webs at the gusset plate connections on all floorbeams, worst case is on floorbeams 0,1,2 of the west span(2011). Rest of floorbeam webs have moderate surface rust(2011).
2013: Floorbeams 4, 5 and 6 in Span 1 and Floorbeams 1, 2 and 6 in Span 2 have section loss (CS4) the entire length. Floorbeams 1 and 2 in Span 1 and Floorbeam 5 in Span 2 have scattered areas of section loss (CS4). The remainder are in CS3. Cross sectional losses do not exceed 5%.
2015: 8 floorbeams have section loss on the bottom flange and bottom of the web for their entire length. Three others have section loss on 6 - 10 feet on the ends (Photos 2-4). However, total cross sectional loss does not exceed 5%.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
423	GUSSET PLATE (PAINT)	1	10-29-2015	56 EA	0	0	56	0	0
			05-13-2015	56 EA	0	0	56	0	0

Notes: |Minor deterioration, surface corrosion and freckled rust(09). 2011 - surface corrosion and paint failure.
2013-2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
380	SECONDARY ELEMENTS	1	10-29-2015	1 EA	0	0	1	0	N/A
			05-13-2015	1 EA	0	0	1	0	N/A

Notes: |Currently most of the lateral bracing under the bridge has been damaged by flooding(09). 2013: There is impact damage to several of the upper horizontal braces.
2013-2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
311	EXPANSION BEARING	2	10-29-2015	4 EA	0	0	4	N/A	N/A
			05-13-2015	4 EA	0	0	4	N/A	N/A

Notes: |Do not appear to be working (rocker bearings). Are severely tilted and should be monitored.
2013: Bearings are severly tilted. Bearing tilt is slightly less or the same as in 2011.
2015: No change. The east bearings are tilted more severely to the west than the west bearings.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
313	FIXED BEARING	1	10-29-2015	4 EA	0	4	0	N/A	N/A
			05-13-2015	4 EA	0	4	0	N/A	N/A

Notes: |Not technically fixed (at abutments). Minor surface rust. Bearings at the abutments need to be cleaned(09).
Extensive debris on west abutment bearing(2011).
2013: No change. Distance from bearings to abutment wall: NE-21", NW 24.25", SE-21.75", SW-25". Lead plate is sliding out from under the SW bearing.
2015: No difference in condition. Distance from bearings to abutment wall: NE-20", NW 24", SE-17.5", SW-24". |

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
210	CONCRETE PIER WALL	2	10-29-2015	26 LF	0	0	26	0	N/A
			05-13-2015	26 LF	0	0	26	0	N/A

Notes: |Debris at center pier should be removed(2009,2010). Pier appears to be out of alignment (lateral W-E movement), apparently by expansion bearings tilted beyond design limits(2011).
2013-2015: Flood debris has accumulated on the upstream side. It appears that the entire bridge is moving to the west, causing the bearings to tip; however, annual surveying would be required to determine which part of the substructure is moving.|

MINNESOTA BRIDGE INSPECTION REPORT
OLD ELEMENT SYSTEM

03/23/2016

Inspected by: POLK COUNTY

BRIDGE 5767 CSAH 1 OVER RED RIVER OF THE NORTH INSP. DATE: 10-29-2015

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
215	CONCRETE ABUTMENT	2	10-29-2015	52 LF	1	0	52	0	N/A
			05-13-2015	52 LF	1	0	52	0	N/A

Notes: |Debris deposited up to abutment. South end exposed piles due to scouring (east). Erosion at se corner of east abutment exposing footings - (07)continues. Abutments appear to be moving towards river. Movement of the piers and/or abutments causing bearings to tilt. 2011 - Both abutments tipped back 3/8" over a 4' level. SW bearing pedalstal is exposed due to undermining. Approximately 1' is exposed and extends 1' under footing. Undermining evident sw bearing ped(2012).
2013: Flood sediment (aggredation) has filled in the erosion at the East Abutment. The undermining on the SW bearing pedestal is still present. One or both abutments are moving; however, annual surveying would be required to determine which part of the substructure is moving.
2015: Erosion is again present at the west abutment. Undermining of the southwest bearing seat extends more than 3'. There are 3' of spalls on the west parapet.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
234	CONCRETE CAP	2	10-29-2015	26 LF	0	26	0	0	N/A
			05-13-2015	26 LF	0	26	0	0	N/A

Notes: |Minor cracking and spalling(09)..
2013-2015: No change.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
387	CONCRETE WINGWALL	2	10-29-2015	4 EA	0	0	4	0	N/A
			05-13-2015	4 EA	0	0	4	0	N/A

Notes: |Corners of se and sw abutments at the wings are delaminating. All 4 wingwalls are spalling and cracking along upper corner due to end post damage(2011).
2013-2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
357	PACK RUST	2	10-29-2015	1 EA	0	1	0	0	N/A
			05-13-2015	1 EA	0	1	0	0	N/A

Notes: |Pack rust is forming between horizontal gusset plate and the floorbeams, but not causing significant stress on elements(2011).
2013-2015: No change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
358	CONC DECK CRACKING	1	10-29-2015	1 EA	0	0	1	0	N/A
			05-13-2015	1 EA	0	0	1	0	N/A

Notes: |Cracking throughout deck.
2013-2015: Transverse cracks over the floorbeams and map cracking throughout.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
359	CONC DECK UNDERSIDE	1	10-29-2015	1 EA	0	0	1	0	0
			05-13-2015	1 EA	0	0	1	0	0

Notes: |Minor transverse cracking.
2013-2015: CS3 due to water saturation 3' (approximately) on either side of every floor beam due to deck leakage. Water saturation is causing deterioration of the floorbeams and stringers. Moved to CS4 because the area of deck cracking and saturation is approximately 20%.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
360	SETTLEMENT	1	10-29-2015	1 EA	0	1	0	N/A	N/A
			05-13-2015	1 EA	0	1	0	N/A	N/A

Notes: |Measuments taken due to substructure movement - see photos
2009 - NE-22 5/8, SW-25 1/2, NW-25 3/16, SE-19 1/4
2010 - NE-22 1/2, SW-25 3/8, NW-25 1/8, SE-18 15/16
2011 - NE-22 1/8, SW-25 5/8, NW-25, SE-18 3/4
2012 - NE-21 3/4, SW-25, NW-24 3/4, SE-18 3/8
2013 - NE-21.25", SW-24 5/8, NW-24.5", SE-17 15/16".
2014 - NE-20 1/8, SW-24 1/4, NW-23 7/8, SE-17 9/16
2015 - NE-20", SW-24". NW 24", SE-17.5" |

03/23/2016

MINNESOTA BRIDGE INSPECTION REPORT
OLD ELEMENT SYSTEM

Inspected by: POLK COUNTY

BRIDGE 5767 **CSAH 1 OVER RED RIVER OF THE NORTH** **INSP. DATE: 10-29-2015**

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
361	SCOUR	1	10-29-2015	1 EA	0	1	0	N/A	N/A
			05-13-2015	1 EA	0	1	0	N/A	N/A

Notes: |Additional action required. Scour evident at both abutments. Scour hole by the SW bearing pedalstal, exposing 1 SF of the underside of the footing(2011). Another scour hole directly below L6-L7 bay in east span. Structural analysis is not warranted at this time(2011). Riprap/fill required SW bearing ped corner(2012).
2013: Flood sediment (aggredation) has filled in the erosion on the East Abutment. The scour and undermining on the SW bearing pedestal is still present(14).
2015: Erosion is again present at the west abutment. Undermining of the southwest bearing seat extends more than 3'. |

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
362	TRAFFIC IMPACT	1	10-29-2015	1 EA	0	1	0	N/A	N/A
			05-13-2015	1 EA	0	1	0	N/A	N/A

Notes: |Impact damage has occurred at several locations but structural integrity of the bridge has not been significantly reduced(09).
2013: Several of the upper wind braces and both portal braces have been struck by high loads and most of the lower lateral bracing has flood impact damage.
2015: It appears that there is further impact damage to the west portal brace. There are several tears and areas of misalignment.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
363	SECTION LOSS	1	10-29-2015	1 EA	0	1	0	0	N/A
			05-13-2015	1 EA	0	1	0	0	N/A

Notes: |Floorbeams and stringers have moderate section loss - mostly on top flange(09).
2013: Section loss on 10 of the 16 floorbeams. No cross sectional loss in excess of 5%.
2015: There is section loss on 11 of the floorbeams, 8 of which have CS4 the entire length. Still no cross sectional loss in excess of 5%.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
964	CRITICAL FINDING	2	10-29-2015	1 EA	1	0	N/A	N/A	N/A
			05-13-2015	1 EA	1	0	N/A	N/A	N/A

Notes: |Bridge closed due to deck failure|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
965	SHEAR CRACKING	2	10-29-2015	1 EA	1	0	0	0	N/A

Notes:

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
966	FRACTURE CRITICAL	2	10-29-2015	1 EA	1	0	0	N/A	N/A
			05-13-2015	1 EA	1	0	0	N/A	N/A

Notes: |< none >|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
981	SIGNING	1	10-29-2015	1 EA	0	1	0	0	0
			05-13-2015	1 EA	0	1	0	0	0

Notes: |SE delineator twisted(2011).
2013: East delineators replaced.
2015: The southeast delineator has minor damage but is still legible.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
982	GUARDRAIL	1	10-29-2015	1 EA	0	0	1	N/A	N/A
			05-13-2015	1 EA	0	0	1	N/A	N/A

Notes: |54 lf of guardrail installed on the North Dakota side(09). None on minnesota side. 2011- SW rail has impact damage where end treatment has broken away from the metal post and the bolt on first wooden post is turned out.
2013: Still no guardrail on east end. Southwest guardrail has been repaired.
2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
984	DRAINAGE	1	10-29-2015	1 EA	0	1	0	N/A	N/A
			05-13-2015	1 EA	0	1	0	N/A	N/A

Notes: |Deck drains require cleaning(2011). Drain pipe bent between L5-L6 west span, north truss(2011). Bottom drain bracing member is bent between L2-L3 east span, north truss. Drains clean in 2012 but mud buildup on deck.
2013-2015: All deck drains are open.|

MINNESOTA BRIDGE INSPECTION REPORT
OLD ELEMENT SYSTEM

03/23/2016

Inspected by: POLK COUNTY

BRIDGE 5767 CSAH 1 OVER RED RIVER OF THE NORTH INSP. DATE: 10-29-2015

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
985	SLOPES	1	10-29-2015	1 EA	0	1	0	N/A	N/A
			05-13-2015	1 EA	0	1	0	N/A	N/A

Notes: |Undermining at SE bearing pedestal - 3 to 5'hole(2010). Debris in truss and at piers(2009,2010). (08)Riprap placed at east abutment, south end. Ditch cleaned SW in 2010. Tree trimming required(2010). Flood debris east slope and sw(2011). Severe erosion due to scour east and west slopes(2011). Debris at SW corner(2012).
2013: Riprap installed late 2012 east abutment.
(14)Significant amount of debris built up on upstream side of pier. (14)Trees trimmed east side.
2015: There is debris build-up on both ends of the west abutment.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
986	CURB & SIDEWALK	1	10-29-2015	1 EA	0	1	0	N/A	N/A
			05-13-2015	1 EA	0	1	0	N/A	N/A

Notes: |Curb has moderate damage and deterioration at panel point locations(09).
2013-2015: No significant change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
988	MISCELLANEOUS	1	10-29-2015	1 EA	0	1	0	N/A	N/A
			05-13-2015	1 EA	0	1	0	N/A	N/A

Notes: |This element is used to monitor debris that require removal. 2011 - debris buildup is significant at piers and abutments.
2013-2015: No change.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
967	GUSSET DISTORTION	1	10-29-2015	1 EA	0	1	0	0	N/A
			05-13-2015	1 EA	0	1	0	0	N/A

Notes: |2011: West span gusset plate distortion measurements: L1S(1/16" Ext GP Top Free Edge), L5S(1" EXT GP W Free Edge), L6S(1/2" Ext GP Top Free Edge) and east span gusset plates L1N(1/8" EXT GP W Edge), L5N(1/8" EXT GP Top Free Edge) are bowed. anything over 1/8" bowing is from impact damage due to flood debris.
2013: No significant change.|

General Notes: *PHOTO NO. 718 BUILT IN 1939 STEEL HIGH TRUSS

FRACTURE CRITICAL INSPECTION COMPLETED BY MNDOT ON JULY 30, 1996, 7-13-2001, 6-13-2006, 9-13-2007, 5-18-2009 and 5/17/2011. HERE ARE SOME OF THE GENERAL COMMENTS:

1. ALL ROCKER BEARINGS APPEAR TO BE LOCKED.
2. NORTH AND SOUTH TRUSS - LOWER CHORD: SCATTERED PAINT FAILURE AND ACTIVE CORROSION IS PRESENT.
3. NORTH AND SOUTH TRUSS - LOWER CHORD PANEL POINTS: WEST BRIDGE, SOUTH TRUSS AT POINT L6, 2in. AWAY FROM THE GUSSET PLATE, THERE IS AN INDENTION ON THE EXTERIOR SIDE (FACIA) OF THE DIAGONAL (12in. LONG X 1.25in. IN DEPTH). WEST BRIDGE, SOUTH TRUSS AT POINT L4, THERE IS AN INDENTION IN THE GUSSET PLATE ON THE EXTERIOR SIDE (FACIA) OF THE PANEL POINT (8in. LONG X 1in. IN DEPTH). PAINT FAILURE.
4. NORTH AND SOUTH TRUSS - UPPER CHORD PANEL POINTS: PAINT SYSTEM CATEGORIZED AS CONDITION 2.
5. NORTH AND SOUTH TRUSS - FLOORBEAMS, DIAGONALS, AND VERTICALS: PAINT SYSTEM FOR THE FLOOR BEAMS CATEGORIZED AS CONDITION 3. ACTIVE CORROSION IS PRESENT. THE PAINT SYSTEM AND CORROSION OF THE DIAGONALS WOULD BE CATEGORIZED AS CONDITION 3. THE PAINT SYSTEM AND CORROSION OF THE VERTICALS WOULD BE CATEGORIZED AS CONDITION 2. WIND BRACING DAMAGED IN SEVERAL LOCATIONS. TRUSS IMPACT DAMAGE: EAST SPAN- NORTH TRUSS, L0-U1 DAMAGE 5in. ABOVE CURB NORTH TRUSS, U1-L2 DAMAGE 3in. AND 6in. ABOVE CURB SOUTH TRUSS, L3-U4 DAMAGE 2in. ABOVE CURB EAST AND WEST PORTAL DAMAGE WEST TRUSS- SOUTH TRUSS, LATERAL MEMBER DAMAGE SOUTH TRUSS, L5-U5 DAMAGE 6-7in ON INSIDE FLANGE SOUTH TRUSS, L6-U6 DAMAGE 5in ON OUTSIDE FLANGE WEST PORTAL DAMAGE. Underwater inspection-9/18/07

Underwater inspection completed September 18, 2007. General comments: Debris at south end along pier 1, light scaling along entire perimeter of pier, scour depression 1 foot deep by 4 feet at pier 1, vertical cracks up to 1/8 inch on both faces of pier 1. Monitor timber debris buildup. Underwater 2012 - see report - moderate to heavy timber buildu

Appendix C

FAA 333 Exemption

FAA Certificate of Authorization

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

January 13, 2016

Exemption No. 14334
Regulatory Docket No. FAA–2015–4923

Mr. Barritt Lovelace
Regional Manager
Collins Engineers Inc.
1599 Selby Avenue, Suite 206
St. Paul, MN 55104

Dear Mr. Lovelace:

This letter is to inform you that we have granted your request for exemption. It transmits our decision, explains its basis, and gives you the conditions and limitations of the exemption, including the date it ends.

By letter dated July 29, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Collins Engineers Inc. (hereinafter petitioner or operator) for an exemption. The petitioner requested to operate an unmanned aircraft system (UAS) to conduct aerial mapping, and structural inspection applications.

See the docket, at www.regulations.gov, for the petition submitted to the FAA describing the proposed operations and the regulations that the petitioner seeks an exemption.

The FAA has determined that good cause exists for not publishing a summary of the petition in the Federal Register because the requested exemption would not set a precedent, and any delay in acting on this petition would be detrimental to the petitioner.

Airworthiness Certification

The UAS proposed by the petitioner is a SenseFly eXom.

In accordance with the statutory criteria provided in Section 333 of Public Law 112–95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

The Basis for Our Decision

You have requested to use a UAS for aerial data collection[1]. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA–2014–0352), 11109 to Clayco, Inc. (*see* Docket No. FAA–2014–0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA–2014–0382), 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA–2014–0642), and 12645 to Allied Drones (*see* Docket No. FAA-2014-0804), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

Having reviewed your reasons for requesting an exemption, I find that—

- They are similar in all material respects to relief previously requested in Grant of Exemption Nos. 11062, 11109, 11112, 11213, and 12645;
- The reasons stated by the FAA for granting Exemption Nos. 11062, 11109, 11112, 11213, and 12645 also apply to the situation you present; and
- A grant of exemption is in the public interest.

Our Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 106(f), 40113, and 44701, delegated to me by the Administrator, Collins Engineers Inc. is granted an exemption from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b), to the extent necessary to allow the petitioner to operate a UAS to perform aerial data collection. This exemption is subject to the conditions and limitations listed below.

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[1] Aerial data collection includes any remote sensing and measuring by an instrument(s) aboard the UA. Examples include imagery (photography, video, infrared, etc.), electronic measurement (precision surveying, RF analysis, etc.), chemical measurement (particulate measurement, etc.), or any other gathering of data by instruments aboard the UA.

Conditions and Limitations

In this grant of exemption, Collins Engineers Inc. is hereafter referred to as the operator.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

1. Operations authorized by this grant of exemption are limited to the SenseFly eXom when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.

2. Operations for the purpose of closed-set motion picture and television filming are not permitted.

3. The UA may not be operated at a speed exceeding 87 knots (100 miles per hour). The exemption holder may use either groundspeed or calibrated airspeed to determine compliance with the 87 knot speed restriction. In no case will the UA be operated at airspeeds greater than the maximum UA operating airspeed recommended by the aircraft manufacturer.

4. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL). Altitude must be reported in feet AGL.

5. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued airman medical certificate or U.S. driver's license.

6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.

7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating documents must be accessible during UAS operations and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operating documents, the conditions and limitations herein take precedence and must be followed.

Otherwise, the operator must follow the procedures as outlined in its operating documents. The operator may update or revise its operating documents. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator or any law enforcement official upon request. The operator must also present updated and revised documents if it petitions for extension or amendment to this grant of exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for an amendment to its grant of exemption. The FAA's UAS Integration Office (AFS−80) may be contacted if questions arise regarding updates or revisions to the operating documents.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g., replacement of a flight critical component, must undergo a functional test flight prior to conducting further operations under this exemption. Functional test flights may only be conducted by a PIC with a VO and must remain at least 500 feet from other people. The functional test flight must be conducted in such a manner so as to not pose an undue hazard to persons and property.

9. The operator is responsible for maintaining and inspecting the UAS to ensure that it is in a condition for safe operation.

10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight.

11. The operator must follow the UAS manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements for the aircraft and aircraft components.

12. Each UAS operated under this exemption must comply with all manufacturer safety bulletins.

13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be

operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles, and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.

15. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.

16. The UA may not operate within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart, unless a letter of agreement with that airport's management is obtained or otherwise permitted by a COA issued to the exemption holder. The letter of agreement with the airport management must be made available to the Administrator or any law enforcement official upon request.

17. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.

18. For tethered UAS operations, the tether line must have colored pennants or streamers attached at not more than 50 foot intervals beginning at 150 feet above the surface of the earth and visible from at least one mile. This requirement for pennants or streamers is not applicable when operating exclusively below the top of and within 250 feet of any structure, so long as the UA operation does not obscure the lighting of the structure.

19. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property.

20. The PIC must abort the flight in the event of unpredicted obstacles or emergencies.

21. The PIC is prohibited from beginning a flight unless (considering wind and forecast weather conditions) there is enough available power for the UA to conduct the intended operation and to operate after that for at least 5 minutes or with the reserve power recommended by the manufacturer if greater.

22. Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA). All operations shall be conducted in accordance with an ATO-issued COA. The exemption holder may apply for a new or amended COA if it intends to conduct operations that cannot be conducted under the terms of the enclosed COA.

23. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N–Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.

24. Documents used by the operator to ensure the safe operation and flight of the UAS and any documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.

25. The UA must remain clear and give way to all manned aviation operations and activities at all times.

26. The UAS may not be operated by the PIC from any moving device or vehicle.

27. All Flight operations must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures unless:
    a. Barriers or structures are present that sufficiently protect nonparticipating persons from the UA and/or debris in the event of an accident. The operator must ensure that nonparticipating persons remain under such protection. If a situation arises where nonparticipating persons leave such protection and are within 500 feet of the UA, flight operations must cease immediately in a manner ensuring the safety of nonparticipating persons; and
    b. The owner/controller of any vessels, vehicles, or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

    The PIC, VO, operator trainees or essential persons are not considered nonparticipating persons under this exemption.

28. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.

29. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported

to the FAA's UAS Integration Office (AFS−80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov.

If this exemption permits operations for the purpose of closed-set motion picture and television filming and production, the following additional conditions and limitations apply.

30. The operator must have a motion picture and television operations manual (MPTOM) as documented in this grant of exemption.

31. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
    a. Dates and times for all flights;
    b. Name and phone number of the operator for the UAS aerial filming conducted under this grant of exemption;
    c. Name and phone number of the person responsible for the on-scene operation of the UAS;
    d. Make, model, and serial or N−Number of UAS to be used;
    e. Name and certificate number of UAS PICs involved in the aerial filming;
    f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;
    g. Signature of exemption holder or representative; and
    h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.

32. Flight operations may be conducted closer than 500 feet from participating persons consenting to be involved and necessary for the filming production, as specified in the exemption holder's MPTOM.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.

This exemption terminates on January 31, 2018, unless sooner superseded or rescinded.

Sincerely,

John S. Duncan
Director, Flight Standards Service

Enclosure

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
CERTIFICATE OF WAIVER OR AUTHORIZATION

ISSUED TO
Any Operator with a valid Section 333 Grant of Exemption

This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.

OPERATIONS AUTHORIZED
Operation of Unmanned Aircraft Systems in accordance with the operators' Section 333 Grant of Exemption at or below 200 feet Above Ground Level (AGL) in the National Airspace System (NAS).

LIST OF WAIVED REGULATIONS BY SECTION AND TITLE
N/A

STANDARD PROVISIONS

1. A copy of the application made for this certificate shall be attached and become a part hereof.
2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations.
3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein.
4. This certificate is nontransferable.

Note-This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.

SPECIAL PROVISIONS

Special Provisions are set forth and attached.

This certificate has the same effective dates as the Grant of Exemption and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative.

BY DIRECTION OF THE ADMINISTRATOR

/S/

FAA Headquarters, AJV-115
(Region)

Jacqueline R. Jackson
(Signature)

Manager, UAS Tactical Operations Section
(Title)

This COA terminates two years from the date of a valid Section 333 Grant of Exemption, unless sooner superseded, rescinded, or cancelled.

FAA Form 7711-1 (7-74)

STANDARD PROVISIONS

A. General.

1. The approval of this COA is effective only with an approved Section 333 FAA Grant of Exemption.

2. A copy of the COA including the special limitations must be immediately available to all operational personnel at each operating location whenever UAS operations are being conducted.

3. This authorization may be canceled at any time by the Administrator, the person authorized to grant the authorization, or the representative designated to monitor a specific operation. As a general rule, this authorization may be canceled when it is no longer required, there is an abuse of its provisions, or when unforeseen safety factors develop. Failure to comply with the authorization is cause for cancellation. The operator will receive written notice of cancellation.

B. Safety of Flight.

1. The operator or pilot in command (PIC) is responsible for halting or canceling activity in the COA area if, at any time, the safety of persons or property on the ground or in the air is in jeopardy, or if there is a failure to comply with the terms or conditions of this authorization.

See-and-Avoid

Unmanned aircraft have no on-board pilot to perform see-and-avoid responsibilities; therefore, when operating outside of active restricted and warning areas approved for aviation activities, provisions must be made to ensure an equivalent level of safety exists for unmanned operations consistent with 14 CFR Part 91 §91.111, §91.113 and §91.115.

a. The pilot in command (PIC) is responsible:

- To remain clear and give way to all manned aviation operations and activities at all times,
- For the safety of persons or property on the surface with respect to the UAS, and
- For compliance with CFR Parts 91.111, 91.113 and 91.115

b. UAS pilots will ensure there is a safe operating distance between aviation activities and unmanned aircraft (UA) at all times.

c. Visual observers must be used at all times and maintain instantaneous communication with the PIC.

d. The PIC is responsible to ensure visual observer(s) are:

- Able to see the UA and the surrounding airspace throughout the entire flight, and
- Able to provide the PIC with the UA's flight path, and proximity to all aviation activities and other hazards (e.g., terrain, weather, structures) sufficiently for the PIC to exercise effective control of the UA to prevent the UA from creating a collision hazard.

e. Visual observer(s) must be able to communicate clearly to the pilot any instructions required to remain clear of conflicting traffic.

2. Pilots are reminded to follow all federal regulations e.g. remain clear of all Temporary Flight Restrictions, as well as following the exemption granted for their operation.

3. The operator or delegated representative must not operate in Prohibited Areas, Special Flight Rule Areas or, the Washington National Capital Region Flight Restricted Zone. Such areas are depicted on charts available at http://www.faa.gov/air_traffic/flight_info/aeronav/. Additionally, aircraft operators should beware of and avoid other areas identified in Notices to Airmen (NOTAMS) which restricts operations in proximity to Power Plants, Electric Substations, Dams, Wind Farms, Oil Refineries, Industrial Complexes, National Parks, The Disney Resorts, Stadiums, Emergency Services, the Washington DC Metro Flight Restricted Zone, Military or other Federal Facilities.

4. All aircraft operated in accordance with this Certificate of Waiver/Authorization must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N-Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be) as large as practicable.

C. Reporting Requirements

1. Documentation of all operations associated with UAS activities is required regardless of the airspace in which the UAS operates. NOTE: Negative (zero flights) reports are required.

2. The operator must submit the following information through mailto:9-AJV-115-UASOrganization@faa.gov on a monthly basis:
   a. Name of Operator, Exemption number and Aircraft registration number
   b. UAS type and model
   c. All operating locations, to include location city/name and latitude/longitude
   d. Number of flights (per location, per aircraft)
   e. Total aircraft operational hours
   f. Takeoff or Landing damage

g. Equipment malfunctions. Reportable malfunctions include, but are not limited to the following:

(1) On-board flight control system

(2) Navigation system

(3) Powerplant failure in flight

(4) Fuel system failure

(5) Electrical system failure

(6) Control station failure

3. The number and duration of lost link events (control, performance and health monitoring, or communications) per UA per flight.

D. **Notice to Airmen (NOTAM).**

A distant (D) NOTAM must be issued when unmanned aircraft operations are being conducted. This requirement may be accomplished:

a. Through the operator's local base operations or NOTAM issuing authority, or

b. By contacting the NOTAM Flight Service Station at 1-877-4-US-NTMS (1-877-487-6867) not more than 72 hours in advance, but not less than 24 hours prior to the operation, unless otherwise authorized as a special provision. The issuing agency will require the:

(1) Name and address of the pilot filing the NOTAM request

(2) Location, altitude, or operating area

(3) Time and nature of the activity.

(4) Number of UAS flying in the operating area.

AIR TRAFFIC CONTROL SPECIAL PROVISIONS

A. **Coordination Requirements.**

1. Operators and UAS equipment must meet the requirements (communication, equipment and clearance) of the class of airspace they will operate in.

2. Operator filing and the issuance of required distance (D) NOTAM, will serve as advance ATC facility notification of UAS operations in an area.

3. Operator must cancel NOTAMs when UAS operations are completed or will not be conducted.

4. Coordination and deconfliction between Military Training Routes (MTRs) is the operator's responsibility. When identifying an operational area the operator must

evaluate whether an MTR will be affected. In the event the UAS operational area overlaps (5 miles either side of centerline) an MTR, the operator will contact the scheduling agency 24 hours in advance to coordinate and deconflict. Approval from the scheduling agency is not required. Scheduling agencies are listed in the Area Planning AP/1B Military Planning Routes North and South America, if unable to gain access to AP/1B contact the FAA at email address mailto:9-AJV-115-UASOrganization@faa.gov with the IR/VR routes affected and the FAA will provide the scheduling agency information. If prior coordination and deconfliction does not take place 24 hours in advance, the operator must remain clear of all MTRs.

B. **Communication Requirements.**

1. When operating in the vicinity of an airport without an operating control tower, announce your operations in accordance with the FAA Aeronautical Information Manual (AIM) 4-1-9 Traffic Advisory Practices at Airports without Operating Control Towers.

C. **Flight Planning Requirements.**

Note: For all UAS requests not covered by the conditions listed below, the exemption holder may apply for a new Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA) at https://oeaaa.faa.gov/oeaaa/external/uas/portal.jsp

This COA will allow small UAS (55 pounds or less) operations during daytime VFR conditions under the following conditions and limitations:

(1) At or below 200 feet AGL; and

(2) Beyond the following distances from the airport reference point (ARP) of a public use airport, heliport, gliderport, seaplane base and military airports listed in the Airport/Facility Directory, Alaska Supplement, or Pacific Chart Supplement of the U.S. Government Flight Information Publications.

a) 5 nautical miles (NM) from an airport having an operational control tower; or

b) 3 NM from an airport having a published instrument flight procedure, but not having an operational control tower; or

c) 2 NM from an airport not having a published instrument flight procedure or an operational control tower; or

d) 2 NM from a heliport, gliderport or seaplane base

D. **Emergency/Contingency Procedures.**

1. Lost Link/Lost Communications Procedures:

- If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property and land.

- The PIC must abort the flight in the event of unpredicted obstacles or emergencies.

2. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries defined in this COA must be reported to the FAA via email at mailto:9-AJV-115-UASOrganization@faa.gov within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: **www.ntsb.gov**

AUTHORIZATION
This Certificate of Waiver or Authorization does not, in itself, waive any Title 14 Code of Federal Regulations, nor any state law or local ordinance. Should the proposed operation conflict with any state law or local ordinance, or require permission of local authorities or property owners, it is the responsibility of the operator to resolve the matter. This COA does not authorize flight within Special Use airspace without approval from the scheduling agency. The operator is hereby authorized to operate the small Unmanned Aircraft System in the National Airspace System.

Appendix D

Airport Permission

From:	SKyTractor
To:	Barritt Lovelace
Subject:	RE: Nielsville Airport
Date:	Thursday, March 31, 2016 10:57:57 AM
Attachments:	image001.png image002.png

Your work Apr 20-22, 2016 will not interfere with our operation.
Thank you.

From: Barritt Lovelace [mailto:blovelace@collinsengr.com]
Sent: Wednesday, March 30, 2016 11:36 AM
To: skytractor@rrv.net
Subject: Nielsville Airport

Following up on our conversation today. We will be performing a bridge inspection using a drone on Bridge 5676 located on CSAH 1 over the Red River just west of Nielsville, MN on April 20-22. Please confirm that our work will not interfere with your airport operations. If you have any questions please let me know. Thank you,

Barritt

Barritt Lovelace, P.E.*
Regional Manager
COLLINS ENGINEERS, INC.
1599 Selby Avenue, Suite 206
St. Paul, MN 55104
Office 651-646-8502
Direct 651-212-4075
Mobile 651-341-4039
blovelace@collinsengr.com
24-Hour Emergency Response 877.346.3234
*Licensed in MN, CA, IA, SD and ND
Visit us at www.collinsengr.com

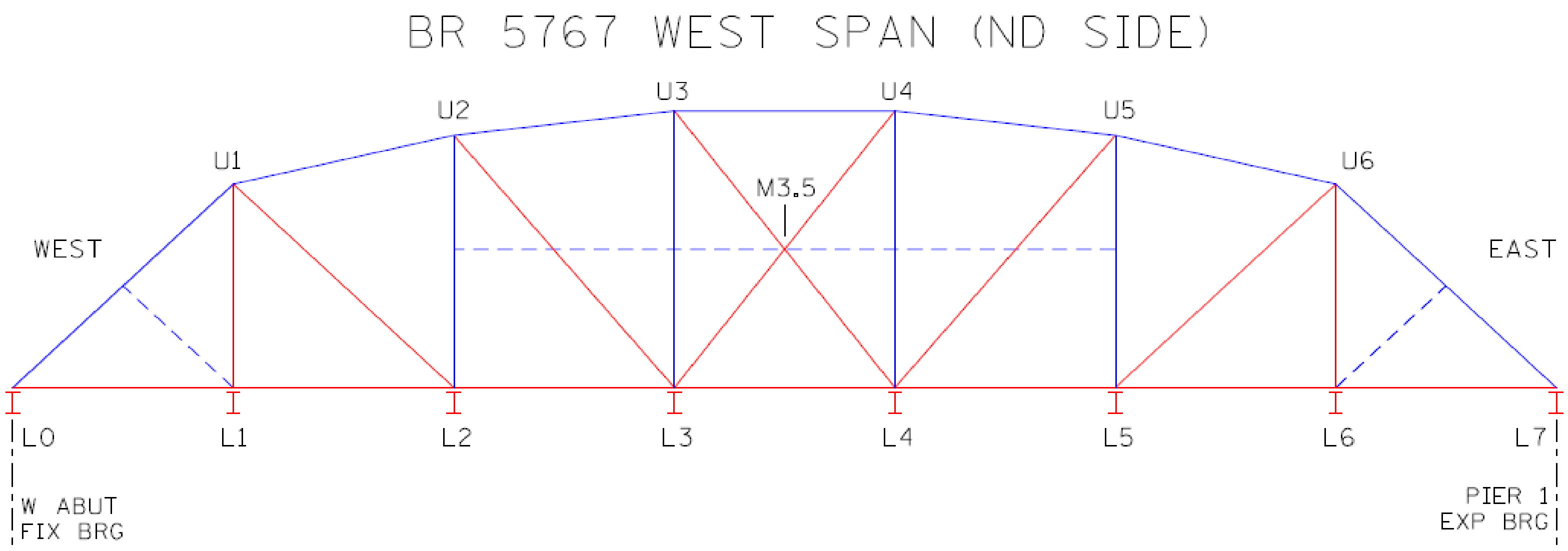
Appendix E

Deck Inspection Memo

Deck Delamination Calculation Spreadsheet

BR 5767 Deck Delamination Survey

Date of Inspection: 4/18/2016



Enter Percent unsound for each segment:
(Each segment 6' X 25')

NORTH TRUSS

S1	20	40	70	40	30	20	50
S2	20	20	30	25	10	60	40
S3	30	40	40	50	20	40	50
S4	50	70	30	40	20	40	60

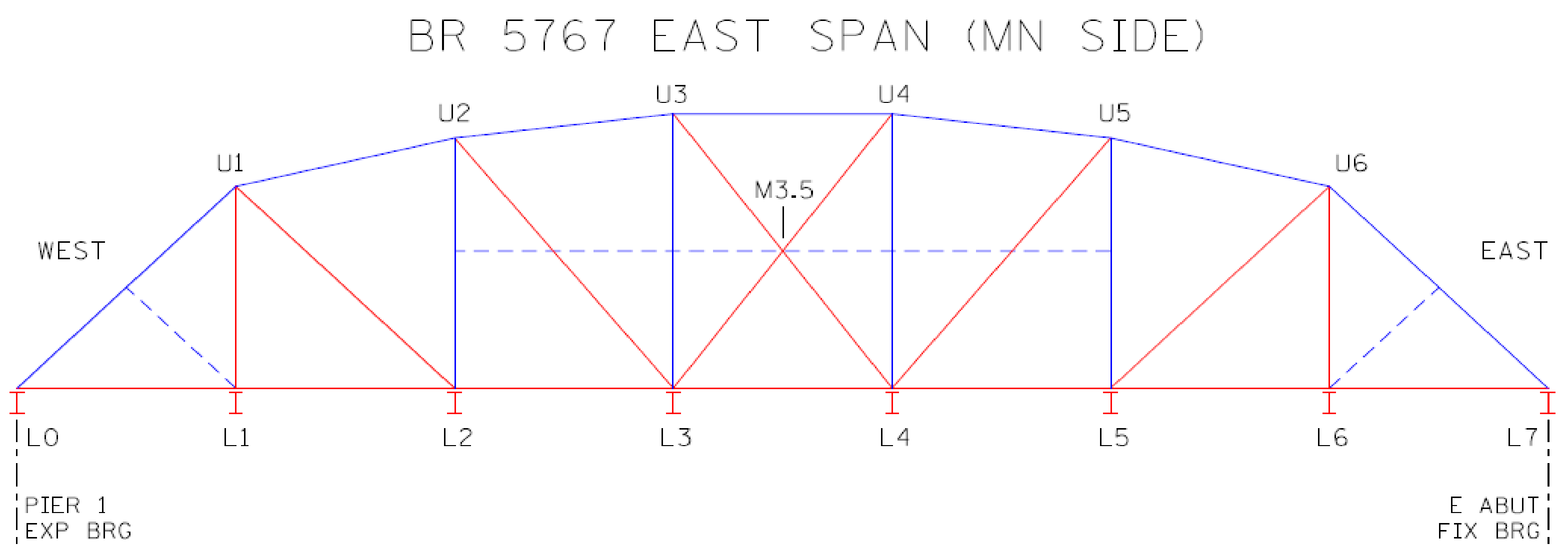
SOUTH TRUSS

Deck width:	**24**	ft
Panel Length:	**25**	ft
No. of Panels:	**7**	
Deck Area:	**4200**	sq. ft.

% Unsound:	**38**	
Area Unsound:	**1583**	sq. ft.

BR 5767 Deck Delamination Survey

Date of Inspection: 4/18/2016



Enter Percent unsound for each segment:
(Each segment 6' X 25')

NORTH TRUSS

S1	20	40	70	40	30	20	50
S2	20	20	30	25	10	60	40
S3	30	40	40	50	20	40	50
S4	50	70	30	40	20	40	60

SOUTH TRUSS

Deck width:	**24**	ft
Panel Length:	**25**	ft
No. of Panels:	**7**	
Deck Area:	**4200**	sq. ft.

% Unsound:	**38**	
Area Unsound:	**1583**	sq. ft.

728 East Beaton Drive Suite 101
PO Box 190
West Fargo, ND 58078-2650
701 232 5353
kljeng.com

Technical Memorandum

Date: 9/18/2015

To: Corwyn Martin, Traill County Highway Superintendent
Richard Sanders, Polk County Engineer

From: Dustin Kinnischtzke

RE: Nielsville Bridge Deck Inspection Findings

Introduction

The Nielsville Bridge is a double span thru truss bridge. It is located 8 miles east and 7 miles north of Hillsboro ND, or 2 miles west of Nielsville MN. This bridge is a ND/MN border crossing across the Red River that joins Traill County Highway 17 with Polk County Highway 1.

On 9/14/15, a hole was discovered in the concrete bridge deck. This hole is approximately 2' x 2' in area and located in the eastbound lane near the first floor beam east of the western abutment. In light of this discovery, the bridge was closed that same day. KLJ inspected the bridge deck on 9/17/15 to evaluate the extent of concrete deterioration. The purpose of this memorandum is to detail the findings of that inspection.

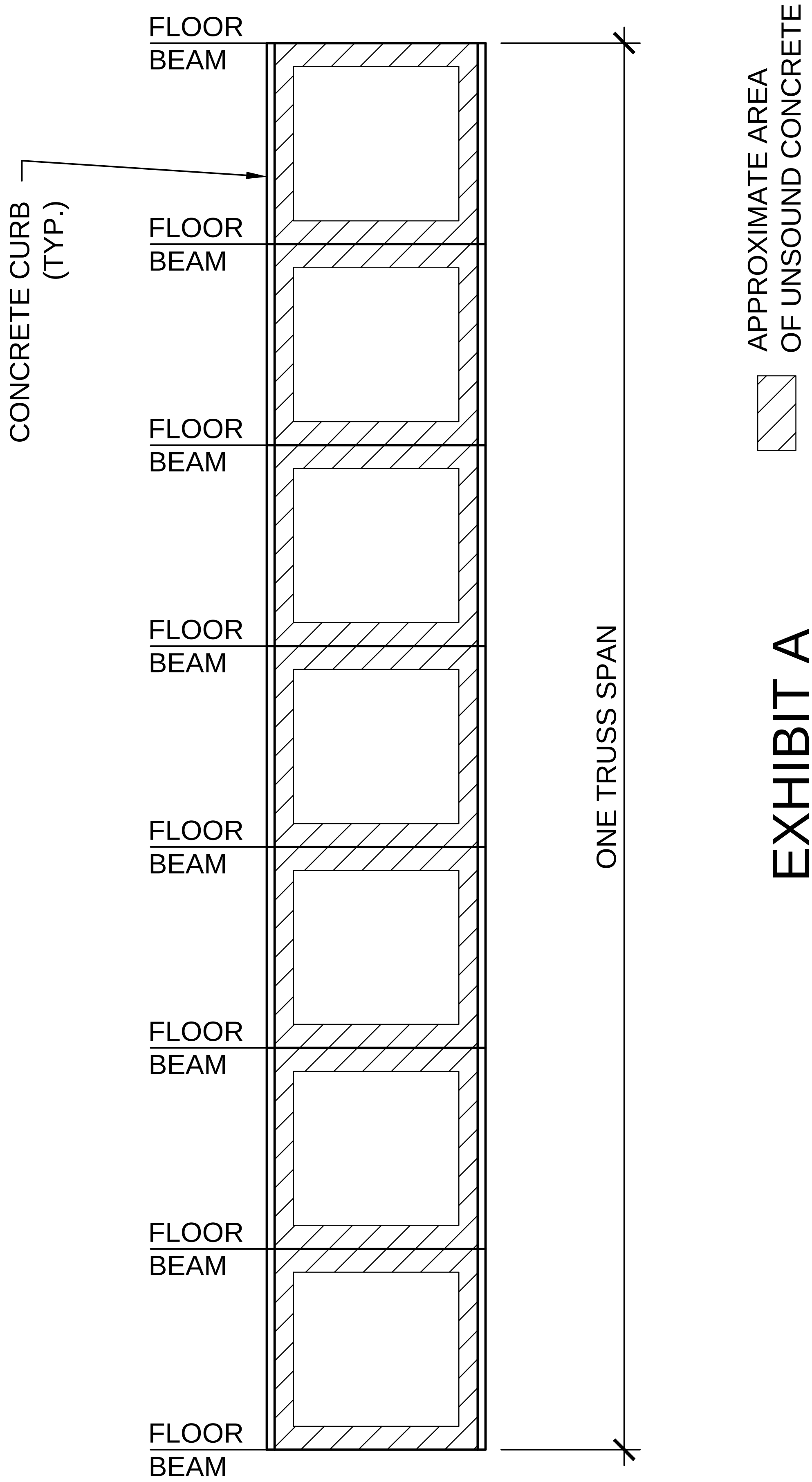
Inspection Findings

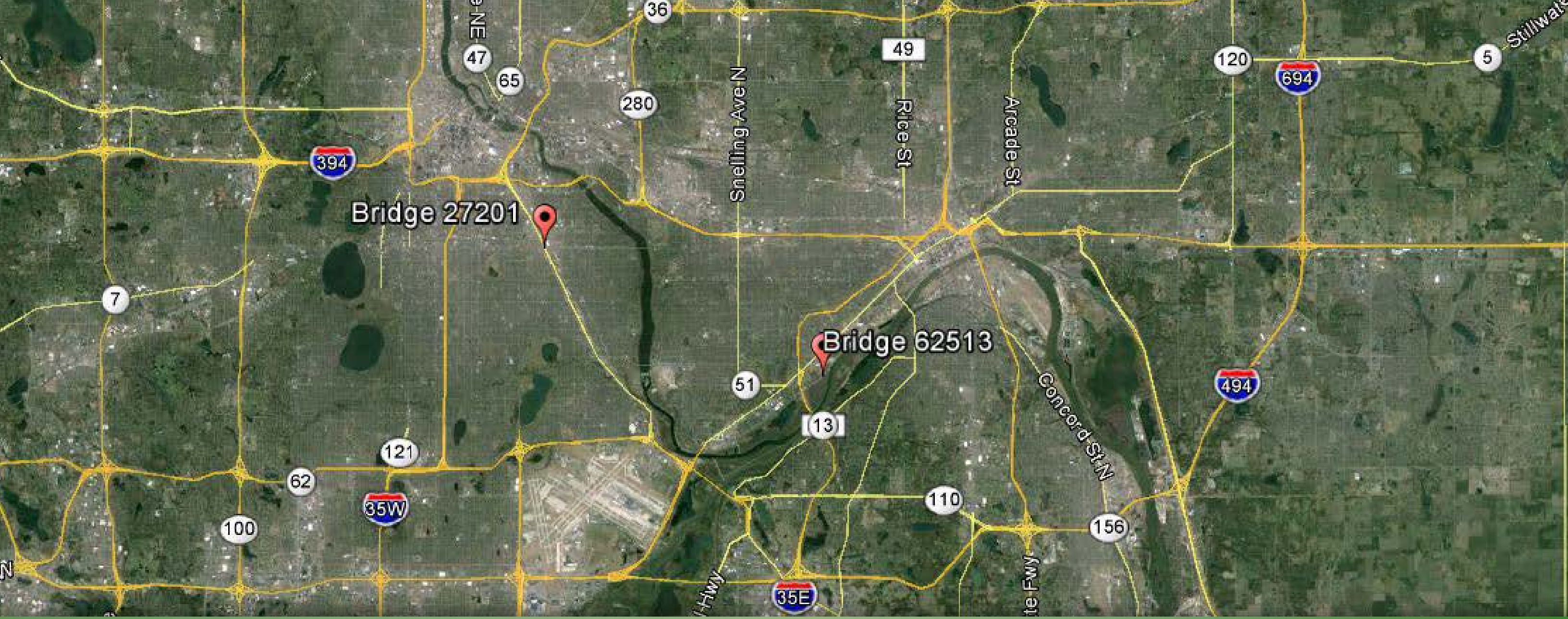
KLJ used chains to approximate where the areas of the concrete deck are unsound. Chaining is a technique that is commonly used to detect delaminations in concrete. The chain is dragged along the concrete surface and distinct hollow sounds can be heard when delaminations are encountered. It should be noted that the chain survey that was conducted only gives an approximate idea of where the unsound concrete areas can be found. In order to get a more precise idea of the unsound concrete areas, the areas would have to be marked and measured as they were chained.

Unsound concrete was detected around all of the asphalt-patched areas near floor beams and typically extended 3'-4' beyond the patching limits. The hole that has already developed was at one such patched area over a floor beam. Unsound concrete was also detected inside both curbs for the entire length of the bridge. These areas seemed to range from 2'-3' inside the curbs. The attached exhibit (Exhibit A) shows the approximate areas where unsound concrete was discovered. Based on this initial survey, the percentage of the concrete deck that may contain unsound concrete ranges between 40%-50%.

A chain survey will not reveal the depths of the unsound concrete. Based on the hole that that recently formed in the deck, it is likely that the deteriorated concrete extends nearly full depth in the areas over the floor beams. Depths of the unsound concrete would have to ultimately be verified with concrete coring. At this point, our recommendation is to further investigate the extent of deterioration of the concrete deck prior to initiating any repairs or reopening the bridge.

EXHIBIT A


FLOOR BEAM
FLOOR BEAM
FLOOR BEAM
FLOOR BEAM
FLOOR BEAM
FLOOR BEAM
FLOOR BEAM
FLOOR BEAM
CONCRETE CURB (TYP.)
ONE TRUSS SPAN
APPROXIMATE AREA OF UNSOUND CONCRETE



Unmanned Aerial System Bridge Inspection Study Phase II

Metro Bridges Fieldwork

Investigation and Safety Plan

7/28/16

Prepared for:

MINNESOTA DEPARTMENT OF TRANSPORTATION

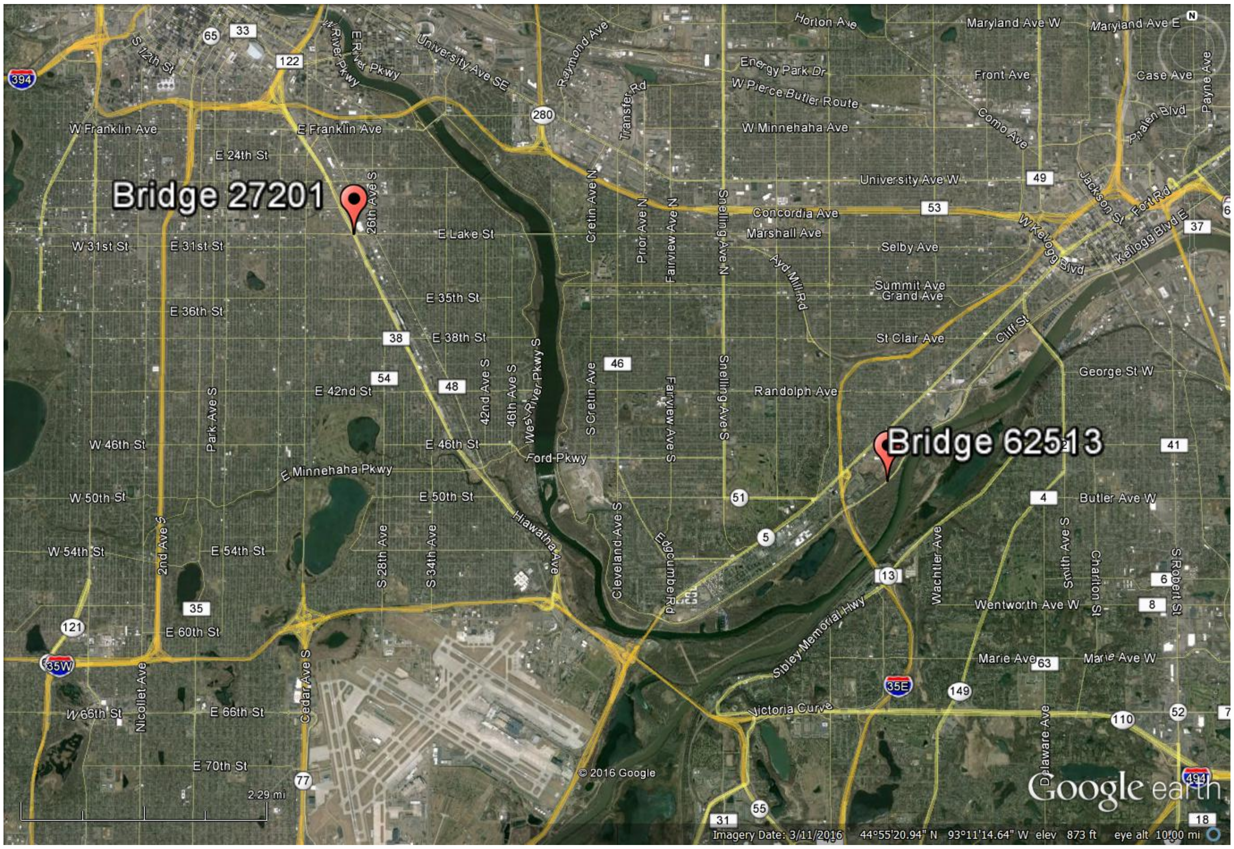
Prepared by:

COLLINS ENGINEERS INC.

1599 Selby Avenue
St. Paul, MN 55104
651.646.8502 • www.collinsengr.com

PROJECT SUMMARY

Project:	Unmanned Aerial System Bridge Inspection Demonstration Project Phase II
Purpose of Project:	The overall goal of the Unmanned Aerial System (UAS) Bridge Inspection Demonstration Project is to study the effectiveness of UAS technology when applied to bridge safety inspections.
Field Team:	Jennifer Zink - MnDOT Project Manager Barritt Lovelace – Collins Engineers - Project Manager, Quality Mangement Mark Stern – Collins Engineers - UAS Pilot in Command
Field Date(s):	July 28th, 2016, Working Hours 7:00 am – 5 pm
Project Location:	Bridge 27201, Hiawatha Avenue (MNTH 55) over Lake Street, Minneapolis, MN Bridge 62513, Shepard Road (MSAS 194), St Paul, MN
Bridge Owner:	Bridge 27201, MnDOT Bridge 62513 – The City of St Paul
Map:	Google Map of Bridge Site https://www.google.com/maps/@44.9316026,93.2060736,13z/data=!3m1!4b1!4m2!6m1!1szan_XSKnMF9U.kPY3npxTmqDc



Overall Bridge Location Map

1.0 INTRODUCTION

1.1 Project Overview

Increasing bridge maintenance and inspection costs are a concern for existing bridges in Minnesota. These additional costs can be minimized and the quality of inspections can be improved by utilizing Unmanned Aerial Systems (UAS). In the summer of 2015, MnDOT performed a Phase I study to evaluate the use of UAS for bridge inspections and the resulting study was published by the MnDOT Research Office. Based on the conclusions and recommendations of the first study, the overall goal of this Phase II contract is to further evaluate the effectiveness of UAS as they apply to Bridge Safety Inspections. This project will involve utilizing UAS to evaluate four structures to determine their effectiveness as a tool for bridge safety inspections. The structure types include a steel box girder, a steel culvert, a steel high truss and a steel open spandrel arch bridge. The Sensefly eXom, an inspection specific UAS, will be utilized to conduct the fieldwork. The study will culminate in a report detailing newer technology that is specific to inspection, a cost comparison to traditional access methods, and advantages and disadvantages of using the UAS during an actual inspection. The project will also include the development of a UAS best practices document based on the results of the study.

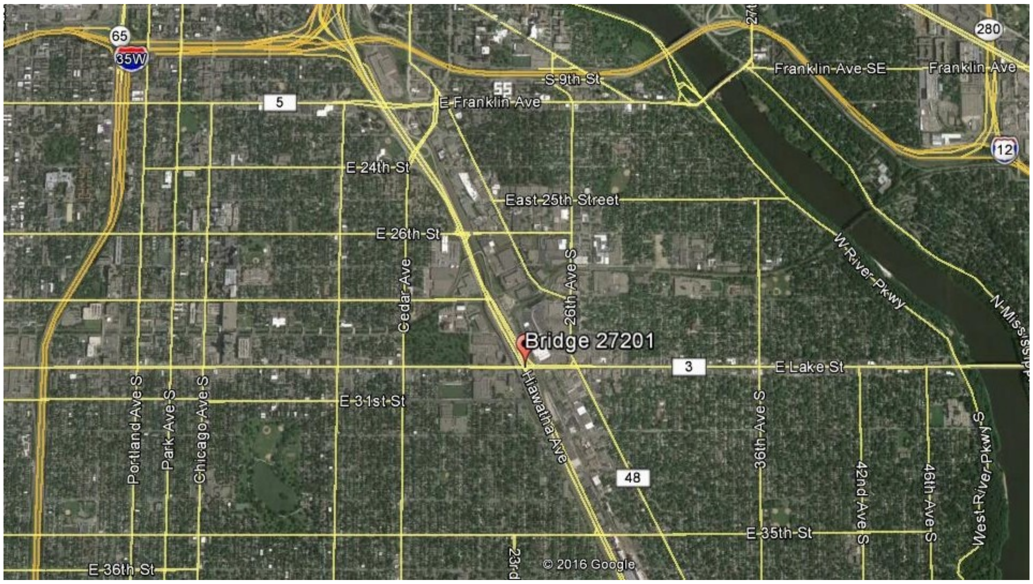
2.0 INVESTIGATION PLAN

The following describes the inspection plan for the Bridge 27201 and Bridge 62513. The location, structure description, access methods, investigation methods and a site specific safety analysis for each bridge are detailed below.

2.1 Bridge 27201 – Steel Box Girder

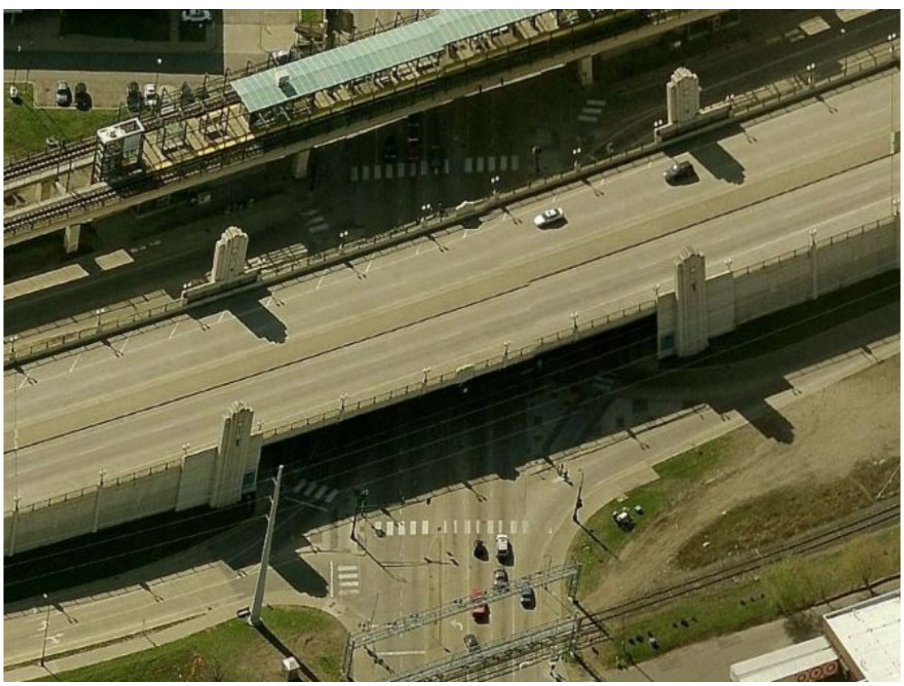
2.1.1 Location

Bridge 27201 is located in Minneapolis, Minnesota, and it carries Hiawatha Avenue (MNTH 55) over Lake Street.



2.1.2 Structure Description

Bridge 27201 was constructed in 1996 and is a 3 span 505-foot long steel box girder bridge. The center main span length is 235 feet. The inventory and inspection report can be found in Appendix B.



2.1.3 Access Methods

The bridge will be accessed from the entry points of the box girders. The inside of the box girder will be flown from one end to the other to investigate the interior of the structure. The UAS will be launched and flown from locations that are within the limits of the normal MnDOT confined space inspection .The UAS will not be flown from private property at any time.

2.1.4 Investigation Methods

The bridge will be inspected with the use of UAS technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAS. Any additional deficiencies discovered will be noted as well. The main focus of this effort is to study the effectiveness of the platform for confined space inspections.

2.1.5 Site Specific Safety and Privacy

2.1.5.1 A job hazard analysis has been prepared and will be utilized to facilitate daily site safety briefings. This document can be found in Appendix A.

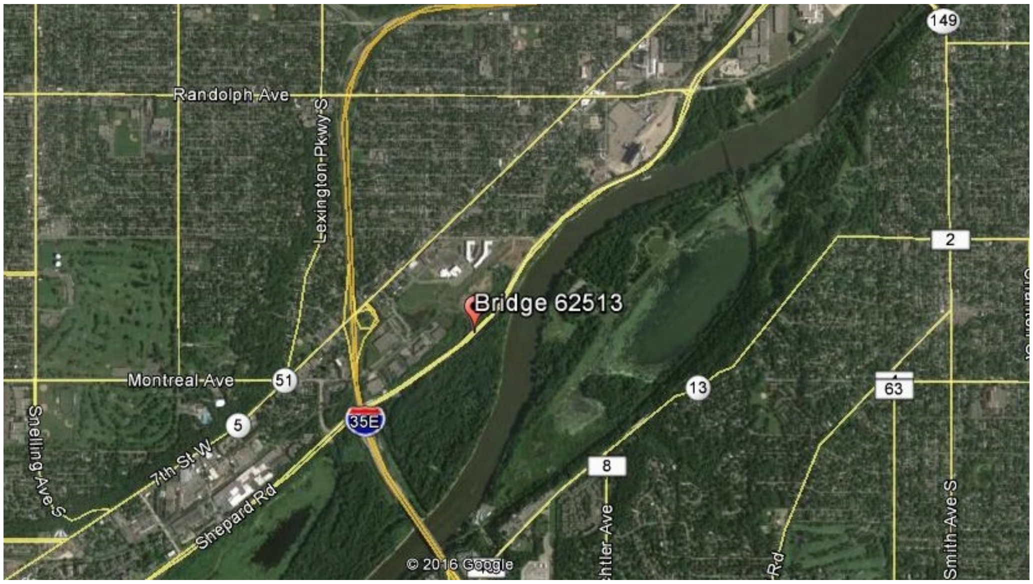
2.1.5.2 There is no public access to the inside of the box girder. The UAS will be flown such that it never leaves this enclosed environment. The inspection team will wear the proper personal protection equipment at all times including hard hats, safety glasses, reflective vests, specific confined space equipment, and fall protection..

2.1.5.3 Bridge 27201 is located in an urban area. The inspection will occur inside of the box girder so privacy is not expected to be an issue but efforts will be made to not include the public in any photos or video taken during the fieldwork.

2.2 Bridge 62513 – Steel Culvert

2.2.1 Location

Bridge 62513 is located in Saint Paul, Minnesota, and it carries Shepard Road (MSAS 194).



2.2.2 Structure Description

Bridge 62513 is a 263-foot long steel culvert that spans approximately 22 feet. Originally constructed in 1965, the barrel was extended at both ends in 1993. The inventory and inspection report can be found in Appendix B.

2.2.3 Access Methods

The bridge will be accessed from both barrel ends. The bridge will be flown from one end to the other to investigate the interior of the barrel. The roadway above the culvert will not be flown as part of this investigation.

The UAS will be launched and flown from locations that are within the limits of the normal MnDOT inspection which generally includes areas immediately inside the barrel. The UAS will not be flown from private property at any time.

2.2.4 Investigation Methods

The bridge will be inspected with the use of UAS technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAS. Any additional deficiencies discovered will be noted as well. The main focus of this effort is to study the effectiveness of the platform in culvert barrels.

2.2.5 Site Specific Safety and Privacy

2.2.5.1 A job hazard analysis has been prepared and will be utilized to facilitate daily site safety briefings. This documents can be found in Appendix A.

2.2.5.2 There is currently no public access on either side of the culvert barrel. The UAS will be flown such that it is never outside of the barrel. The inspection team will wear the proper personal protection equipment at all times including hard hats, safety glasses, reflective vests.

2.2.5.3 Bridge 62513 is located in a wooded area owned by the city of St Paul with no public access. Privacy is not expected to be an issue but efforts will be made to not include the public in any photos or video taken during the fieldwork.

Respectfully Submitted,
COLLINS ENGINEERS, INC.

Barritt Lovelace, P.E., Regional Manager

Appendix A
Job Hazard Analysis

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION

Submit to Project Manager / Supervisor for approval prior to commencing work if necessary.

PROJECT INFORMATION:

Collins Project Number:	9336	Date:	4/25/2016
Client:	MnDOT	Prepared By:	Barritt Lovelace
Inspection Team Leader:	Jennifer Zink, Barritt Lovelace	For Date(s):	July 28th, 2016
General Work Location:	Bridge 27201, Minneapolis, MN	Expected Work Duration:	1 Day

REQUIRED SAFETY EQUIPMENT FOR INSPECTION CHECK LIST:

(Check if in Possession; obtain all applicable and required equipment prior to commencing work)

Personal Protective Equipment (PPE)		General Equipment		First Aid / Other:	
Hard Hat:	X	Project Work Plan:	X	First Aid Kit:	X
Safety Glasses:	X	GPS/Atlas/Maps:	X	Sunscreen:	X
Steel Toe Boots:	X	Harness:	X	Insect Repellent:	
Gloves:	X	Stress Release Straps for Harness:	X	Drinking Water:	X
Hearing Protection:		Lanyards:	X	Strobe Lights:	
Reflective Vests:	X	Tethers for Climbing Tools:		Two-Way Radios:	X
Reflective Pants (night work):		Personal Floatation Device:		Mobile Phone:	X
Rope Access Equipment:		:		:	
:		:		:	

WORK LOCATIONS / EMERGENCY CONTACT INFORMATION:

If information is located in field books, work plan, or elsewhere, ensure inspection team is aware and can readily locate.

Mobile phone or other means of contacting emergency personnel must be on site prior to starting inspection.

List complete location information for work in case of need for emergency response. List multiple if required.

Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Bridge 27201	1.2 MI S OF JCT TH 94	MNTH 55 Over Lake Street	Minneapolis, MN

Nearest Hospital Location: Hennepin County Medical Center, 730 S 8th St, Minneapolis, MN 55404

Nearest Police / Fire Phone Numbers: 911

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Assess Site Conditions	**Weather Conditions:**		
	Rain, lightening, extreme temp. or wind, ice, other	Check forecast to be aware of possible inclement weather. Wait for improved conditions (at least 30 minutes after last lightening strike) or limit access to structure. Ensure inspection team is properly clothed and equipped (cold weather clothes, rain gear, etc.)	
	Traffic Conditions:		
	Vehicular traffic	Avoid high volume, high speed areas under construction or otherwise temporarily impeded (accidents, etc.) Wear proper reflective clothing and stay alert and vigilant. Coordinate with local authorities and inform them of our presence. Coordinate with Safety Signs for flagging and lane closure. Park vehicle near lift vehicle.	
	Rail traffic	Coordinate with proper jurisdiction if necessary, and arrange for flagman if required.	
	Boat traffic	Coordinate with proper jurisdiction if necessary, and stay alert for boat traffic and floating debris.	
Access Site	**Vehicular Traffic:**		
	Traffic at site	Park vehicle in safe location 10 foot from roadway edge, or off of roadway when possible.	
	Obstructions:		
	Obstructions (fences, retaining walls, vegetation, water, etc.)	Review previous inspection report, bridge file, and plans prior to inspection. Survey area for safest point of entry.	
	Traffic Control:		
	Traffic control setup	Traffic control should be setup in accordance with jurisdiction standard specifications (State/City/County etc.) or MUTCD. If roadway constraints do not allow for standard setup, competent person(s) should design proper traffic control.	
	Work zone check (traffic control)	Drive through work zone to ensure compliance with work zone standards (proper signage, configuration, etc.). Ensure traffic is flowing through work zone, and not encroaching on work zone.	
Inspection	**General Inspection:**		
	Insects, rodents, reptiles, other animals, poison ivy/oak, sunburn	Perform visual inspection of site prior to beginning work. Contact animal control or client if needed. Use wasp/hornet killer as needed. Wear proper PPE. Wear insect repellent clothing and sunscreen.	
	Sharp objects (rust, galvanizing drips, bolts, edges of plates, angles, etc.)	Visually inspect site for dangers. Wear proper PPE.	
	Slips, trips, and falls	Identify and avoid hazards if possible, guardrails, barriers, steep embankments, grade changes, etc. Wear proper PPE.	
	Vehicular Traffic:		
	Crossing lanes of traffic	Do not attempt to cross lanes of traffic in high volume conditions, low visibility condition, or high speed conditions. Do not cross traffic if traffic can not see you.	
	Traffic encroaching on work zone	Observe erratic drivers and avoid. Position yourself in safe place out of way of traffic when possible (behind guardrail or barrier, well off the road, etc.)	
	Aerial Lifts: * Ensure all team members are properly trained and qualified to operate lift.		
	Fall from height greater than 6 feet	Wear fall protection. Follow Collins fall protection and rescue plan. Report any incidents to team leader immediately.	
	Overhead hazards (electrical lines, bridge beams, etc.). Aerial lifts over water: Proper PPE including PFD, Marine Radio	Visually inspect site for dangers prior to entering lift. Wear proper PPE. Stay a least 10 feet from power lines at all times.	
	Over/Near Water	Wear proper PPE including PFD. Marine Radio to be at site. Throwable life ring to be on site.	

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS (Continued)

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Inspection (continued)	Wading		
	Enter water (slips /falls)	Visually inspect site prior to entering water. Survey area around bridge for best point of entry. Probe ahead of path with rod as entering. All team members aware of inspection POA. When working adjacent to water, you must wear a Personal Flotation Device.	
	Wade inspection / boat traffic / fast current	Stay alert for boat traffic, floating debris and swift currents. Probe ahead of path with rod when moving.	
	Exit water (slips/falls)	All team members assist each other when exiting the water.	
	UAV Concerns	Review and follow operations manual and use radios to communicate with operators to ensure public safety	
	Environmental Concerns	Stay alert for environmental factors.	
Post Inspection	General		
	Health and safety of inspector after inspection	Check inspectors health/condition after inspection. Inform the Team Leader of any inspection related injuries.	
	Work zone break down / vehicular traffic	Follow standards for work zone breakdown. Use proper MOT devices, vehicle with warning lights as needed to breakdown closure in reverse order.	

By signing this JSA, you confirm that each listed hazard has been reviewed during the safety briefing and you fully understand the work and safety procedures that can be utilized to mitigate these potential hazards. Inspectors are to report any physical problems before, during, or after the inspection. All incidents are to be reported to team leader as soon as possible.
Team leader shall complete an incident report and submit to Structural Inspection Program Manager and their respective Regional Manager.

Name / Signature / Date

Team Leader: ____________________ Inspector: ____________________

Inspector: ____________________ Inspector: ____________________

Inspector: ____________________ Inspector: ____________________

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION

Submit to Project Manager / Supervisor for approval prior to commencing work if necessary.

PROJECT INFORMATION:

Collins Project Number:	9336	Date:	4/25/2016
Client:	MnDOT	Prepared By:	Barritt Lovelace
Inspection Team Leader:	Jennifer Zink, Barritt Lovelace	For Date(s):	July 28th, 2016
General Work Location:	Bridge 62513, St Paul, MN	Expected Work Duration:	1 Day

REQUIRED SAFETY EQUIPMENT FOR INSPECTION CHECK LIST:

(Check if in Possession; obtain all applicable and required equipment prior to commencing work)

Personal Protective Equipment (PPE)		General Equipment		First Aid / Other:	
Hard Hat:	X	Project Work Plan:	X	First Aid Kit:	X
Safety Glasses:	X	GPS/Atlas/Maps:	X	Sunscreen:	X
Steel Toe Boots:	X	Harness:		Insect Repellent:	
Gloves:	X	Stress Release Straps for Harness:		Drinking Water:	X
Hearing Protection:		Lanyards:		Strobe Lights:	
Reflective Vests:	X	Tethers for Climbing Tools:		Two-Way Radios:	X
Reflective Pants (night work):		Personal Floatation Device:		Mobile Phone:	X
Rope Access Equipment:		:		:	
:		:		:	

WORK LOCATIONS / EMERGENCY CONTACT INFORMATION:

If information is located in field books, work plan, or elsewhere, ensure inspection team is aware and can readily locate.

Mobile phone or other means of contacting emergency personnel must be on site prior to starting inspection.

List complete location information for work in case of need for emergency response. List multiple if required.

Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Bridge 62513	0.4 MI NE OF JCT TH 35E	MSAS 194 (Shepard Rd)	St Paul, MN

Nearest Hospital Location: United Hospital, 333 N Smith Ave, St Paul, MN 55102

Nearest Police / Fire Phone Numbers: 911

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Assess Site Conditions	**Weather Conditions:**		
	Rain, lightening, extreme temp. or wind, ice, other	Check forecast to be aware of possible inclement weather. Wait for improved conditions (at least 30 minutes after last lightening strike) or limit access to structure. Ensure inspection team is properly clothed and equipped (cold weather clothes, rain gear, etc.)	
	Traffic Conditions:		
	Vehicular traffic	Avoid high volume, high speed areas under construction or otherwise temporarily impeded (accidents, etc.) Wear proper reflective clothing and stay alert and vigilant. Coordinate with local authorities and inform them of our presence. Coordinate with Safety Signs for flagging and lane closure. Park vehicle near lift vehicle.	
	Rail traffic	Coordinate with proper jurisdiction if necessary, and arrange for flagman if required.	
	Boat traffic	Coordinate with proper jurisdiction if necessary, and stay alert for boat traffic and floating debris.	
Access Site	**Vehicular Traffic:**		
	Traffic at site	Park vehicle in safe location 10 foot from roadway edge, or off of roadway when possible.	
	Obstructions:		
	Obstructions (fences, retaining walls, vegetation, water, etc.)	Review previous inspection report, bridge file, and plans prior to inspection. Survey area for safest point of entry.	
	Traffic Control:		
	Traffic control setup	Traffic control should be setup in accordance with jurisdiction standard specifications (State/City/County etc.) or MUTCD. If roadway constraints do not allow for standard setup, competent person(s) should design proper traffic control.	
	Work zone check (traffic control)	Drive through work zone to ensure compliance with work zone standards (proper signage, configuration, etc.). Ensure traffic is flowing through work zone, and not encroaching on work zone.	
Inspection	**General Inspection:**		
	Insects, rodents, reptiles, other animals, poison ivy/oak, sunburn	Perform visual inspection of site prior to beginning work. Contact animal control or client if needed. Use wasp/hornet killer as needed. Wear proper PPE. Wear insect repellent clothing and sunscreen.	
	Sharp objects (rust, galvanizing drips, bolts, edges of plates, angles, etc.)	Visually inspect site for dangers. Wear proper PPE.	
	Slips, trips, and falls	Identify and avoid hazards if possible, guardrails, barriers, steep embankments, grade changes, etc. Wear proper PPE.	
	Vehicular Traffic:		
	Crossing lanes of traffic	Do not attempt to cross lanes of traffic in high volume conditions, low visibility condition, or high speed conditions. Do not cross traffic if traffic can not see you.	
	Traffic encroaching on work zone	Observe erratic drivers and avoid. Position yourself in safe place out of way of traffic when possible (behind guardrail or barrier, well off the road, etc.)	
	Aerial Lifts: * Ensure all team members are properly trained and qualified to operate lift.		
	Fall from height greater than 6 feet	Wear fall protection. Follow Collins fall protection and rescue plan. Report any incidents to team leader immediately.	
	Overhead hazards (electrical lines, bridge beams, etc.). Aerial lifts over water: Proper PPE including PFD, Marine Radio	Visually inspect site for dangers prior to entering lift. Wear proper PPE. Stay a least 10 feet from power lines at all times.	
	Over/Near Water	Wear proper PPE including PFD. Marine Radio to be at site. Throwable life ring to be on site.	

COLLINS ENGINEERS JOB SAFETY ANALYSIS
BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS (Continued)

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Inspection (continued)	Wading		
	Enter water (slips /falls)	Visually inspect site prior to entering water. Survey area around bridge for best point of entry. Probe ahead of path with rod as entering. All team members aware of inspection POA. When working adjacent to water, you must wear a Personal Flotation Device.	
	Wade inspection / boat traffic / fast current	Stay alert for boat traffic, floating debris and swift currents. Probe ahead of path with rod when moving.	
	Exit water (slips/falls)	All team members assist each other when exiting the water.	
	UAV Concerns	Review and follow operations manual and use radios to communicate with operators to ensure public safety	
	Environmental Concerns	Stay alert for environmental factors.	
Post Inspection	General		
	Health and safety of inspector after inspection	Check inspectors health/condition after inspection. Inform the Team Leader of any inspection related injuries.	
	Work zone break down / vehicular traffic	Follow standards for work zone breakdown. Use proper MOT devices, vehicle with warning lights as needed to breakdown closure in reverse order.	

By signing this JSA, you confirm that each listed hazard has been reviewed during the safety briefing and you fully understand the work and safety procedures that can be utilized to mitigate these potential hazards. Inspectors are to report any physical problems before, during, or after the inspection. All incidents are to be reported to team leader as soon as possible.
Team leader shall complete an incident report and submit to Structural Inspection Program Manager and their respective Regional Manager.

Name / Signature / Date

Team Leader: ______________________ Inspector: ______________________

Inspector: ______________________ Inspector: ______________________

Inspector: ______________________ Inspector: ______________________

Appendix B

Bridge Inventory and Inspection Reports

Mn/DOT Structure Inventory Report

Bridge ID: 27201 **TH 55 over LAKE ST** Date: 01/21/2016

+ GENERAL +

Agency Br. No.	**Crew** 7647
District METRO	**Maint. Area** 5A
County	27 - HENNEPIN
City	MINNEAPOLIS
Township	
Desc. Loc.	1.2 MI S OF JCT TH 94
Sect., Twp., Range	01 - 028NN - 24W
Latitude	44d 56m 54.32s
Longitude	93d 14m 17.48s
Custodian	STATE HWY
Owner	STATE HWY
Inspection By	METRO DISTRICT
BMU Agreement	
Year Built	1996
Year Fed Rehab	
Year Remodeled	
Temp	
Plan Avail.	CENTRAL

+ STRUCTURE +

Service On	HIGHWAY
Service Under	HIGHWAY
Main Span Type	CSTL BOX GIRD
Main Span Detail	
Appr. Span Type	
Appr. Span Detail	
Skew	25R
Culvert Type	
Barrel Length	

Number of Spans

MAIN: 3 APPR: 0 TOTAL: 3

Main Span Length	235.0 ft
Structure Length	504.8 ft
Deck Width	110.2 ft
Deck Material	C-I-P CONCRETE
Wear Surf Type	LOW SLUMP CONC
Wear Surf Install Year	1996
Wear Course/Fill Depth	0.17 ft
Deck Membrane	NONE
Deck Protect.	EPOXY COATED REBAR
Deck Install Year	1996
Structure Area	55,629 sq ft
Roadway Area	46,446 sq ft
Sidewalk Width - L/R	
Curb Height - L/R	
Rail Codes - L/R	51 51

+ ROADWAY +

Bridge Match ID (TIS)	1
Roadway O/U Key	1-ON
Route Sys/Nbr	MNTH 55

Roadway Name or Description

TH 55 (HIAWATHA AVE)

Roadway Function	MAINLINE
Roadway Type	2 WAY TRAF
Control Section (TH Only)	24
Ref. Point (TH Only)	193+00.324
Date Opened to Traffic	07-01-1999
Detour Length	0 mi.
Lanes	4 Lanes ON Bridge
ADT (YEAR)	40,623 (2012)
HCADT	2,031
Functional Class.	URB/OTH PR ART

+ RDWY DIMENSIONS +

If Divided	**NB-EB**	**SB-WB**
Roadway Width	46.0 ft	46.0 ft
Vertical Clearance		
Max. Vert. Clear.		
Horizontal Clear.	99.8 ft	
Lateral Clr. - Lt/Rt		
Appr. Surface Width	98.0 ft	
Roadway Width	92.0 ft	
Median Width	14.0 ft	

+ MISC. BRIDGE DATA +

Structure Flared	NO
Parallel Structure	NONE
Field Conn. ID	BOLTED
Cantilever ID	

Foundations

Abut.	CONC - FTG PILE
Pier	CONC - FTG PILE
Historic Status	NOT ELIGIBLE
On - Off System	ON

+ PAINT +

Year Painted 1996	**Pct. Unsound** 2 %
Painted Area	144,000 sf
Primer Type	3309-ORGANIC ZINC
Finish Type	URETHANE

+ BRIDGE SIGNS +

Posted Load	NOT REQUIRED
Traffic	NOT REQUIRED
Horizontal	NOT REQUIRED
Vertical	NOT APPLICABLE

+ INSPECTION +

Deficient Status	ADEQ
Sufficiency Rating	95.0
Last Inspection Date	06-03-2014
Inspection Frequency	24
Inspector Name	METRO
Structure	A-OPEN

+ NBI CONDITION RATINGS +

Deck 1 % UNSOUND	6
Superstructure	8
Substructure	7
Channel	N
Culvert	N

+ NBI APPRAISAL RATINGS +

Structure Evaluation	7
Deck Geometry	9
Underclearances	9
Waterway Adequacy	N
Approach Alignment	8

+ SAFETY FEATURES +

Bridge Railing	1-MEETS STANDARDS
GR Transition	1-MEETS STANDARDS
Appr. Guardrail	1-MEETS STANDARDS
GR Termini	1-MEETS STANDARDS

+ IN DEPTH INSP. +

Frac. Critical	
Underwater	
Pinned Asbly.	
Spec. Feat.	

+ WATERWAY +

Drainage Area	
Waterway Opening	
Navigation Control	NOT APPL
Pier Protection	
Nav. Vert./Horz. Clr.	
Nav. Vert. Lift Bridge Clear.	
MN Scour Code	A-NON WATERWAY
Scour Evaluation Year	

+ CAPACITY RATINGS +

Design Load	HS25
Operating Rating	HS 41.60
Inventory Rating	HS 24.80
Posting	
Rating Date	02-23-2010

Mn/DOT Permit Codes

A: 1 B: 1 C: 1

V2006

Mn/DOT Structure Inventory Report

Bridge ID: 27201 **TH 55 over LAKE ST** Date: 01/21/2016

+ GENERAL +		+ ROADWAY +		+ INSPECTION +	
Agency Br. No.	**Crew** 7647	**Bridge Match ID (TIS)**	2	**Deficient Status**	ADEQ
District METRO	**Maint. Area** 5A	**Roadway O/U Key**	2-UNDER	**Sufficiency Rating**	95.0
County	27 - HENNEPIN	**Route Sys/Nbr**	CSAH 3	**Last Inspection Date**	06-03-2014
City	MINNEAPOLIS	**Roadway Name or Description**		**Inspection Frequency**	24
Township		LAKE ST (CSAH 3)		**Inspector Name**	METRO
Desc. Loc.	1.2 MI S OF JCT TH 94	**Roadway Function**	MAINLINE	**Structure**	A-OPEN
Sect., Twp., Range	01 - 028NN - 24W	**Roadway Type**	2 WAY TRAF	+ NBI CONDITION RATINGS +	
Latitude	44d 56m 54.32s	**Control Section (TH Only)**		**Deck** 1 % UNSOUND	6
Longitude	93d 14m 17.48s	**Ref. Point (TH Only)**		**Superstructure**	8
Custodian	STATE HWY	**Date Opened to Traffic**		**Substructure**	7
Owner	STATE HWY	**Detour Length**	0 mi.	**Channel**	N
Inspection By	METRO DISTRICT	**Lanes**	6 Lanes UNDER Bridge	**Culvert**	N
BMU Agreement		**ADT (YEAR)**	20,000 (2005)	+ NBI APPRAISAL RATINGS +	
Year Built	1996	**HCADT**		**Structure Evaluation**	7
Year Fed Rehab		**Functional Class.**	URB/MINOR ART	**Deck Geometry**	9
Year Remodeled		+ RDWY DIMENSIONS +		**Underclearances**	9
Temp		**If Divided**	**NB-EB** **SB-WB**	**Waterway Adequacy**	N
Plan Avail.	CENTRAL	**Roadway Width**	82.0 ft	**Approach Alignment**	8
+ STRUCTURE +		**Vertical Clearance**	17.3 ft	+ SAFETY FEATURES +	
Service On	HIGHWAY	**Max. Vert. Clear.**	17.3 ft	**Bridge Railing**	1-MEETS STANDARDS
Service Under	HIGHWAY	**Horizontal Clear.**	99.9 ft	**GR Transition**	1-MEETS STANDARDS
Main Span Type	CSTL BOX GIRD	**Lateral Clr. - Lt/Rt**	49.9 ft	**Appr. Guardrail**	1-MEETS STANDARDS
Main Span Detail		**Appr. Surface Width**	88.0 ft	**GR Termini**	1-MEETS STANDARDS
Appr. Span Type		**Roadway Width**	82.0 ft	+ IN DEPTH INSP. +	
Appr. Span Detail		**Median Width**		**Frac. Critical**	
Skew	25R	+ MISC. BRIDGE DATA +		**Underwater**	
Culvert Type		**Structure Flared**	NO	**Pinned Asbly.**	
Barrel Length		**Parallel Structure**	NONE	**Spec. Feat.**	
Number of Spans		**Field Conn. ID**	BOLTED	+ WATERWAY +	
MAIN: 3 APPR: 0	TOTAL: 3	**Cantilever ID**		**Drainage Area**	
Main Span Length	235.0 ft	**Foundations**		**Waterway Opening**	
Structure Length	504.8 ft	**Abut.**	CONC - FTG PILE	**Navigation Control**	NOT APPL
Deck Width	110.2 ft	**Pier**	CONC - FTG PILE	**Pier Protection**	
Deck Material	C-I-P CONCRETE	**Historic Status**	NOT ELIGIBLE	**Nav. Vert./Horz. Clr.**	
Wear Surf Type	LOW SLUMP CONC	**On - Off System**	ON	**Nav. Vert. Lift Bridge Clear.**	
Wear Surf Install Year	1996	+ PAINT +		**MN Scour Code**	A-NON WATERWAY
Wear Course/Fill Depth	0.17 ft	**Year Painted** 1996	**Pct. Unsound** 2 %	**Scour Evaluation Year**	
Deck Membrane	NONE	**Painted Area**	144,000 sf	+ CAPACITY RATINGS +	
Deck Protect.	EPOXY COATED REBAR	**Primer Type**	3309-ORGANIC ZINC	**Design Load**	HS25
Deck Install Year	1996	**Finish Type**	URETHANE	**Operating Rating**	HS 41.60
Structure Area	55,629 sq ft	+ BRIDGE SIGNS +		**Inventory Rating**	HS 24.80
Roadway Area	46,446 sq ft	**Posted Load**	NOT REQUIRED	**Posting**	
Sidewalk Width - L/R		**Traffic**	NOT REQUIRED	**Rating Date**	02-23-2010
Curb Height - L/R		**Horizontal**	NOT REQUIRED	**Mn/DOT Permit Codes**	
Rail Codes - L/R	51 51	**Vertical**	NOT APPLICABLE	A: 1 B: 1	C: 1

V2006

Mn/DOT BRIDGE INSPECTION REPORT

BRIDGE 27201 TH 55 OVER LAKE ST **INSP. DATE: 06-03-2014**

County: HENNEPIN
City: MINNEAPOLIS
Township:
Section: 01 Township: 028NN Range: 24W
Span Type: CSTL BOX GIRD
NBI Deck: 6 Super: 8 Sub: 7 Chan: N Culv: N

Location: 1.2 MI S OF JCT TH 94
Route: MNTH 55 Ref. Pt.: 193+00.324
Control Section: 24 Maint. Area: 5A
Local Agency Bridge Nbr:

Length: 504.8 ft
Deck Width: 110.2 ft
Rdwy. Area / Pct. Unsnd: 46,446 sq ft 1 %
Paint Area/ Pct. Unsnd: 144,000 sq ft 2 %
Culvert N/A

Open, Posted, Closed: OPEN

Appraisal Ratings - Approach: 8 Waterway: N MN Scour Code: A-NON WATERWAY Def. Stat: ADEQ Suff. Rate: 95.0

Required Bridge Signs - Load Posting: NOT REQUIRED Traffic: NOT REQUIRED
Horizontal: NOT REQUIRED Vertical: NOT APPLICABLE

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
377	LS O/L(CONCDECK-EPX)	2	06-03-2014	55,675 SF	0	55,675	0	0	0
			06-04-2012	55,675 SF	0	55,675	0	0	0
	Notes: | Two lanes NB & SB each. 46, 516 SF Low slump overlay. [2005] NB deck has 20 SF of concrete patches. Estimated delamination <1%. [2010/2014] North end block has 9 SF of spalls & 3 SF of delamination. [2004/08/2014] South end headblock has 5 SF spall & 4 SF concrete patch. Cracks need to be epoxy sealed.|								
300	STRIP SEAL JOINT	2	06-03-2014	235 LF	118	117	0	N/A	N/A
			06-04-2012	235 LF	118	117	0	N/A	N/A
	Notes: | [1996] Type H strip joint at abutments are 5" wide. [2002] Evidence of leaking joint, SBL on the north abutment. [2010] Strip seal at north abutment has closed to less than 2". Strip seal at south abutment has closed to less than 1". [2012] Both strip seals show evidence of significant leakage in the form of abutment staining. [2014] SBL above the north abut left lane has a 3 LF rip in the gland.|								
301	POURED DECK JOINT	2	06-03-2014	470 LF	235	0	235	N/A	N/A
			06-04-2012	470 LF	235	0	235	N/A	N/A
	Notes: | Pourable joints at approaches & end blocks. [2010/2014] North & south end block deck joints has 60% of failure. |								
412	APPR RELIEF JOINT	2	06-03-2014	176 LF	0	82	94	N/A	N/A
			06-04-2012	176 LF	0	156	20	N/A	N/A
	Notes: | [2014] Joint material missing-SW jt. 24 LF, SE jt. 30 LF, NW jt. 16 LF, NE jt. 24 LF. All joints need repair and sealing.|								
321	CONC APPROACH SLAB	2	06-03-2014	4 EA	0	1	3	0	N/A
			06-04-2012	4 EA	0	1	3	0	N/A
	Notes: | 4923 SF low slump overlay south approach, 5211 SF north approach. [2010/2014] SE approach has 82 LF of transverse cracks. SW approach has 75 LF of transverse, 60 LF longitudinal cracks & 20 SF of delamination, 15 SF spall & 20 SF concrete patch. NE approach has 50 LF of transverse cracks, 6 SF spall, 2 spots 2 SF concrete patch. NW approach has 150 LF of transverse cracks, 2 SF delamination, 4 SF spall. |								
333	RAILING - OTHER	2	06-03-2014	1,197 LF	747	450	0	N/A	N/A
			06-04-2012	1,197 LF	747	450	0	N/A	N/A
	Notes: | Rail code #40, Type special concrete rail & 1101 LF Type special ornamental metal rail. [2010/2014] Parapet railing on the deck has 1500 LF of vertical cracks. |								
102	PAINT STL BOX GIRDER	2	06-03-2014	1,998 LF	1,978	20	0	0	0
			06-04-2012	1,998 LF	1,978	20	0	0	0
	Notes: | Four hollow steel box girders. [2010] Walked through inspection. 2 % Unsound paint, bubbled/peeled paint, surface rust. Surface rust under leaching cracks at top flange of web walls. [2012] Exterior of boxes has light paint chalking over traffic and where exposed to direct sunlight. Minor paint failure in isolated areas starting at the lower corners of the boxes (where the bottom flanges meet the webs). There are several holes drilled in the bottom flange of each box at pier 2. The number of holes in each box varies, but there are a minimum of 3 on either side of the bearing stiffener at each bearing location at pier 2, and a maximum of 5. They appear to be misdrilled holes for bearing anchorage bolts, and this is likely an as-built condition. The holes in Box 4 have been filled with caulk.|								
422	PAINTED BEAM ENDS	2	06-03-2014	2 EA	2	0	0	0	0
			06-04-2012	2 EA	2	0	0	0	0
	Notes:								
380	SECONDARY ELEMENTS	2	06-03-2014	1 EA	1	0	0	0	N/A
			06-04-2012	1 EA	1	0	0	0	N/A
	Notes: | 5 Decorative corbels (aluminum) mounted on fascias. Hollow towers (obelisks) at all 4 corners. Steel box girders each have internal diaphragms. Box girder 1: 2nd diaphragm south of pier 2, drilled holes top connection plate.|								

Mn/DOT BRIDGE INSPECTION REPORT

BRIDGE 27201 TH 55 OVER LAKE ST **INSP. DATE: 06-03-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
310	ELASTOMERIC BEARING	2	06-03-2014	16 EA	16	0	0	N/A	N/A
			06-04-2012	16 EA	16	0	0	N/A	N/A
	Notes: | Each abutment has eight elastomeric bearings. [2012] North abutment bearings are in proper alignment for ambient tempurature conditions. South abutment bearings were unable to be accessed during the 2012 inspection.|								
314	POT BEARING	2	06-03-2014	16 EA	16	0	0	N/A	N/A
			06-04-2012	16 EA	16	0	0	N/A	N/A
	Notes: | Piers #1, & #2 have pot bearings. Two interior beams at pier 1 fixed, rest expansion.|								
210	CONCRETE PIER WALL	2	06-03-2014	244 LF	244	0	0	0	N/A
			06-04-2012	244 LF	244	0	0	0	N/A
	Notes: | Area between pier walls & abutments are enclosed (access doors on Lake street). Pier faces have blue decorative tile.|								
215	CONCRETE ABUTMENT	2	06-03-2014	234 LF	92	142	0	0	N/A
			06-04-2012	234 LF	92	142	0	0	N/A
	Notes: | [2002] North abutment has 30 LF of vertical cracks. [2004] South abutment has one horizontal crack full width across the bottom. [2005] Graffiti protection wearing off. [2012] North abutment has moderate staining undernieth girders 1, 2, and 3. The south abutment also has some staining.|								
387	CONCRETE WINGWALL	2	06-03-2014	4 EA	3	1	0	0	N/A
			06-04-2012	4 EA	3	1	0	0	N/A
	Notes: | [2008] 2 SF spall NW wingwall. 10 FT x 20 FT vent SW wingwall (substation inside)|								
358	CONC DECK CRACKING	2	06-03-2014	1 EA	0	0	1	0	N/A
			06-04-2012	1 EA	0	0	1	0	N/A
	Notes: | [2010] Deck surface has 7000 LF of transverse cracks. Epoxy seal is worn off from traffic. |								
359	CONC DECK UNDERSIDE	2	06-03-2014	1 EA	0	0	1	0	0
			06-04-2012	1 EA	0	0	1	0	0
	Notes: | [2010] Underside of the deck & coping has 3500 LF transverse leaching cracks. [2012] The underside fo the deck has transverse leaching cracks approximately every 15 feet, with light efflourencence. There are isolated areas of moderate leaching, and on the south end of the bridge inside the boxes, there are more dense areas of moderate leaching with rust staining being more prevalent in these areas. |								
964	CRITICAL FINDING	2	06-03-2014	1 EA	1	0	N/A	N/A	N/A
			06-04-2012	1 EA	1	0	N/A	N/A	N/A
	Notes:								
982	GUARDRAIL	2	06-03-2014	1 EA	1	0	0	N/A	N/A
			06-04-2012	1 EA	1	0	0	N/A	N/A
	Notes: | Double Platebeam guardrail EB 55 (NW corner) & WB 55 (SE corner) retaining walls.|								
983	PLOWSTRAPS	2	06-03-2014	1 EA	0	0	1	N/A	N/A
			06-04-2012	1 EA	0	0	1	N/A	N/A
	Notes: | [2002/08] 11 plowstraps missing north joint. [2004/08] 5 plowstraps missing at the south joint. [2012/2014] 7 Plowstraps missing at the North abutment EB, 7 Missing at the North abutment WB. 5 Plowstraps missing at the South abutment EB, 1 plow strap missing South abut WB.|								
984	DRAINAGE	2	06-03-2014	1 EA	0	1	0	N/A	N/A
			06-04-2012	1 EA	0	1	0	N/A	N/A
	Notes: | Drop inlets: north & south roadways (left base of curb) & (right base of rail). [2008] South roadway NB 55 right drop inlet full of debris. |								
986	CURB & SIDEWALK	2	06-03-2014	1 EA	0	1	0	N/A	N/A
			06-04-2012	1 EA	0	1	0	N/A	N/A
	Notes: | Deck has 7118 SF raised median (14' wide, 6" high). [99/2008/2012] 840 LF cracks. [2010] Epoxy seal is weathering off. [2014] Curb has 3 SF spall at median SB south end.|								

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: METRO DISTRICT

BRIDGE 27201 **TH 55 OVER LAKE ST** **INSP. DATE: 06-03-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
988	MISCELLANEOUS	2	06-03-2014	1 EA	1	0	0	N/A	N/A
			06-04-2012	1 EA	1	0	0	N/A	N/A

Notes: | Rail mounted ornamental lighting. One light missing at SW obelisk. 6 lights each & 11 black lights each pier 1 & 2. 5 lights each (3 bays), 3 tube lights each (3 bays) between steel beams. Minneapolis Traffic storage span 1 south, Metro bridge storage span 3 north.|

General Notes: Bridge #27201. Year 2014
Bridge constructed in 1997.
[2000/10/2012] Photos.

Note: Need to have a key to get into spans #1 & #3. Metro Bridge Inspection Office has key for span #1. Bridge Supervisors have key for span #3. Substation for light rail inside span #1.

2003 Inspectors: V Desens /K Fuhrman.
2004 Inspectors: V Desens
2005 Inspectors: L Schmid
2006 Inspectors: V Desens
2007 Inspectors: PB Americas Inc
2008 Inspectors: K Fuhrman
2010 Inspectors: K Fuhrman /V Desens /C Hoberg
2012 Inspectors: K Fuhrman /C Hoberg Bridge inspection completed 4 days past 24 month inspection frequency target due to higher priority bridge repair work
2014 Inspectors: K Fuhrman /J Lundeen

South Abutment:
Span 1: (Substation, City of Minneapolis storage inside)
Pierwall 1:
Span 2: East Lake Street
Pierwall 2:
Span 3: (Mn/Dot storage inside)
North Abutment:

Inspector's Signature

Reviewer's Signature / Date

Mn/DOT Structure Inventory Report

Bridge ID: 62513 **MSAS 194(SHEP RD) over TEXACO OIL** Date: 01/21/2016

+ GENERAL +	
Agency Br. No.	
District	METRO **Maint. Area**
County	62 - RAMSEY
City	ST PAUL
Township	
Desc. Loc.	0.4 MI NE OF JCT TH 35E
Sect., Twp., Range	14 - 028NN - 23W
Latitude	44d 54m 56.37s
Longitude	93d 08m 03.65s
Custodian	CITY
Owner	CITY
Inspection By	CITY OF ST PAUL
BMU Agreement	
Year Built	1965
Year Fed Rehab	
Year Remodeled	1992
Temp	
Plan Avail.	NO PLAN

+ STRUCTURE +	
Service On	HWY;PED
Service Under	OTHER
Main Span Type	STEEL LONG SPAN
Main Span Detail	
Appr. Span Type	
Appr. Span Detail	
Skew	35L
Culvert Type	20'X17'
Barrel Length	263 ft
Number of Spans	MAIN: 1 APPR: 0 TOTAL: 1
Main Span Length	22.2 ft
Structure Length	22.2 ft
Deck Width	
Deck Material	N/A
Wear Surf Type	MONOLITHIC CONC
Wear Surf Install Year	
Wear Course/Fill Depth	3.31 ft
Deck Membrane	NONE
Deck Protect.	N/A
Deck Install Year	
Structure Area	
Roadway Area	
Sidewalk Width - L/R	14.0 ft
Curb Height - L/R	
Rail Codes - L/R	NN NN

+ ROADWAY +	
Bridge Match ID (TIS)	1
Roadway O/U Key	1-ON
Route Sys/Nbr	MSAS 194
Roadway Name or Description	MSAS 194
Roadway Function	MAINLINE
Roadway Type	2 WAY TRAF
Control Section (TH Only)	
Ref. Point (TH Only)	
Date Opened to Traffic	
Detour Length	1 mi.
Lanes	4 Lanes ON Bridge
ADT (YEAR)	15,700 (2008)
HCADT	
Functional Class.	URB/OTH PR ART

+ RDWY DIMENSIONS +		
If Divided	**NB-EB**	**SB-WB**
Roadway Width	36.0 ft	36.0 ft
Vertical Clearance		
Max. Vert. Clear.		
Horizontal Clear.		
Lateral Clr. - Lt/Rt		
Appr. Surface Width	88.0 ft	
Roadway Width		
Median Width	5.0 ft	

+ MISC. BRIDGE DATA +	
Structure Flared	NO
Parallel Structure	NONE
Field Conn. ID	
Cantilever ID	
Foundations	
Abut.	N/A
Pier	N/A
Historic Status	NOT ELIGIBLE
On - Off System	ON

+ PAINT +	
Year Painted	**Pct. Unsound**
Painted Area	
Primer Type	
Finish Type	

+ BRIDGE SIGNS +	
Posted Load	NOT REQUIRED
Traffic	NOT REQUIRED
Horizontal	NOT REQUIRED
Vertical	NOT APPLICABLE

+ INSPECTION +	
Deficient Status	ADEQ
Sufficiency Rating	78.3
Last Inspection Date	05-13-2014
Inspection Frequency	24
Inspector Name	STPAUL
Structure	A-OPEN

+ NBI CONDITION RATINGS +	
Deck	N
Superstructure	N
Substructure	N
Channel	N
Culvert	7

+ NBI APPRAISAL RATINGS +	
Structure Evaluation	6
Deck Geometry	N
Underclearances	N
Waterway Adequacy	N
Approach Alignment	8

+ SAFETY FEATURES +	
Bridge Railing	N-NOT REQUIRED
GR Transition	N-NOT REQUIRED
Appr. Guardrail	N-NOT REQUIRED
GR Termini	N-NOT REQUIRED

+ IN DEPTH INSP. +	
Frac. Critical	
Underwater	
Pinned Asbly.	
Spec. Feat.	

+ WATERWAY +	
Drainage Area	
Waterway Opening	
Navigation Control	NOT APPL
Pier Protection	
Nav. Vert./Horz. Clr.	
Nav. Vert. Lift Bridge Clear.	
MN Scour Code	A-NON WATERWAY
Scour Evaluation Year	

+ CAPACITY RATINGS +	
Design Load	UNKN
Operating Rating	HS 24.00
Inventory Rating	HS 16.00
Posting	
Rating Date	01-24-2015
Mn/DOT Permit Codes	A: N B: N C: N

V2006

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: CITY OF ST PAUL

BRIDGE 62513 MSAS 194(SHEP RD) OVER TEXACO OIL INSP. DATE: 05-13-2014

County: RAMSEY
City: ST PAUL
Township:
Section: 14 Township: 028NN Range: 23W
Span Type: STEEL LONG SPAN

Location: 0.4 MI NE OF JCT TH 35E
Route: MSAS 194 Ref. Pt.: 004+00.183
Control Section: Maint. Area:
Local Agency Bridge Nbr:

Length: 22.2 ft
Deck Width:
Rdwy. Area / Pct. Unsnd:
Paint Area/ Pct. Unsnd:
Culvert 20'X17' / 263 ft

NBI Deck: N Super: N Sub: N Chan: N Culv: 7
Open, Posted, Closed: OPEN

Appraisal Ratings - Approach: 8 Waterway: N
MN Scour Code: A-NON WATERWAY Def. Stat: ADEQ Suff. Rate: 78.3

Required Bridge Signs - Load Posting: NOT REQUIRED Traffic: NOT REQUIRED
Horizontal: NOT REQUIRED Vertical: NOT APPLICABLE

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
240	STEEL CULVERT	2	05-13-2014	157 LF	148	9	0	0	N/A
			08-30-2012	157 LF	148	9	0	0	N/A

Notes: |NOTE:
The culvert will be extended south. It is included in the
Shepard Road paving contract. City Project 90-P-1008
constructed a new pavement on the roadway in 1993.
In addition:
30'+ or - of culvert added to south end of barrel. 93.
16' + or - of culvert added to north end of barrel. 93.
The north end of the new culvert = 20'-4" wide at three holes above lower splice. 93.
The south end of the new culvert = 20'-10" wide. 97. This distance
was not measured but looks okay. 98-12
Culvert Measurements:
N. end vertical distance from top inside of arch to ground level = 16' 1" High. 89-90.
The above distance was not measured but looks okay. 91-10.
The original N. end horizontal = 20'-6 3/8" wide on inside face.
After the 1993 addition this is 20'- 5 1/2" wide.
S. end horizontal 20'-2 1/2" Wide.) 3 holes above lower spice.
After the 1993 addition the original south end horizontal = 19'-11 5/8".
The original south end vertical from top outside of arch to ground level = 16' 5". 89-90.
The above distance was not measured but looks okay. 91-12
Barrel & floor: 10' long bulge about 100 feet from south end
the bulge is about 7' up from the floor.
H = 19'-0 5/8" at about 100' from South end at metal strip in
ceiling. 90. The above distance was not measured but looks okay. 91-12

Minor to moderate deterioration. 2012-14
Slight deflection/distortion present. See notes above. 2012-14|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
388	CULVERT HEADWALL	2	05-13-2014	2 EA	2	0	0	0	N/A
			08-30-2012	2 EA	2	0	0	0	N/A

Notes: |Under construction 93. In good condition 96-12

Does this element apply? please check next inspection. 2012-14|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
964	CRITICAL FINDING	2	05-13-2014	1 EA	1	0	N/A	N/A	N/A
			08-30-2012	1 EA	1	0	N/A	N/A	N/A

Notes: |PONTIS element inspection comments -
Structure 62513 -
Date 2003-11-12 -
Previous comments > DO NOT DELETE THIS CRITICAL FINDING SMART FLAG.|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
985	SLOPES	2	05-13-2014	2 EA	2	0	0	N/A	N/A
			08-30-2012	2 EA	2	0	0	N/A	N/A

Notes: |added element # 985 slopes and slope protection. 2012

Need current photos of N.side and S.side slopes. 2012|

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: CITY OF ST PAUL

BRIDGE 62513 MSAS 194(SHEP RD) OVER TEXACO OIL INSP. DATE: 05-13-2014

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
987	ROADWAY OVER CULVERT	2	05-13-2014	2 EA	2	0	0	N/A	N/A
			08-30-2012	2 EA	2	0	0	N/A	N/A

Notes: |added element # 987 roadway over culvert. 2012
Need current photos of WB and EB roadway. 2012-14|

General Notes: Under brush has grown up around the structure ends. 2010-14

Inspector's Signature

Reviewer's Signature / Date

APPENDIX B: UAS PRODUCT INFORMATION

albris

senseFly

The intelligent **mapping** & **inspection** drone

B-1


senseFly

3 reasons to choose albris

- ## 1 flight, 3 types of imagery

  With the senseFly albris you can switch between capturing high-res still, thermal and video imagery during the same flight, without landing to change cameras. Thanks to the drone's unobstructed field of view and its head's 180º vertical range of motion, you can capture clear, stabilised imagery ahead of, above and below the albris.

- ## Advanced situational awareness

  The senseFly albris features five dual-sensor modules, positioned around the drone. These provide the situational awareness required to operate albris close to structures and surfaces, even in confined environments, in order to achieve sub-millimetre image resolutions (without the movement issues caused by zooming in from afar).

- ## Choose your flight mode

  The albris offers full flight mode flexibility. Choose the mode that best fits your project: an Autonomous, GPS-guided mapping mission or a live-streaming Interactive ScreenFly flight. Or start in mapping mode and 'go live' on demand.

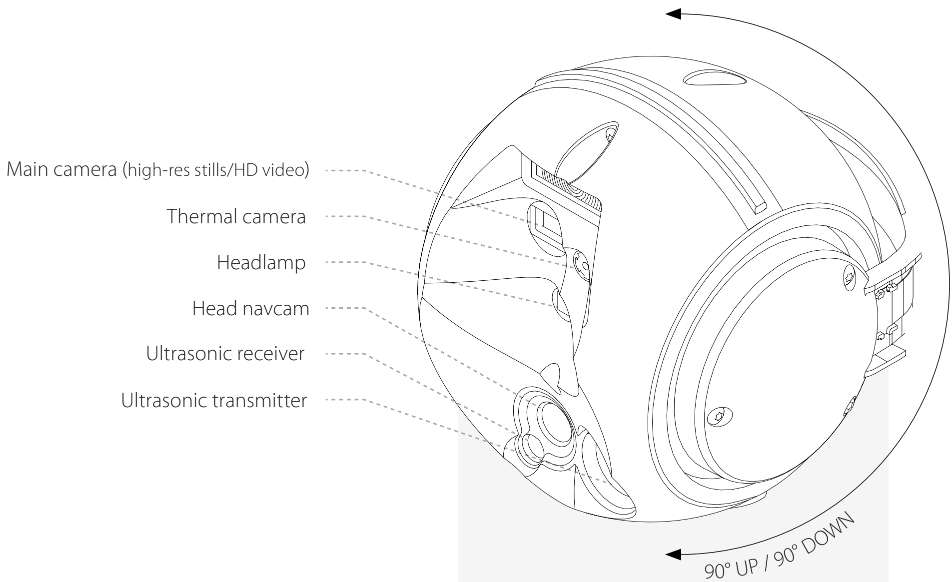
Main camera
(HD video & high-res still camera)

Thermal camera + edge overlay
(video & images)

Head navcam
(wide-angle video camera)

1 flight, 3 types of imagery

The senseFly albris is a sensor-rich platform with the widest camera breadth of any civilian drone. Its fully stabilised TripleView camera head allows you to switch between HD and thermal video imagery, live during your flight, plus you can capture high-resolution still images on demand. All of this data can be saved for further analysis post-flight, and all without landing to change payloads.



TripleView head

* 180° vertical range of motion
* 6x digital zoom
* Approx. 1 mm still image resolution at 5 m (16.4 ft) distance
* Active gimbal stabilisation
* Unobstructed field of view

Advanced situational awareness

The senseFly albris is designed from the ground up to perform live inspections of buildings and other structures. Its onboard navcams and ultrasonic sensors provide the visual and proximity feedback you require to take the right decisions and maximise every mission's chances of success.

Navcams

Ultrasonic sensors

Head position

Navigate, check for obstacles, keep constant distance from vertical surfaces

Left/Right

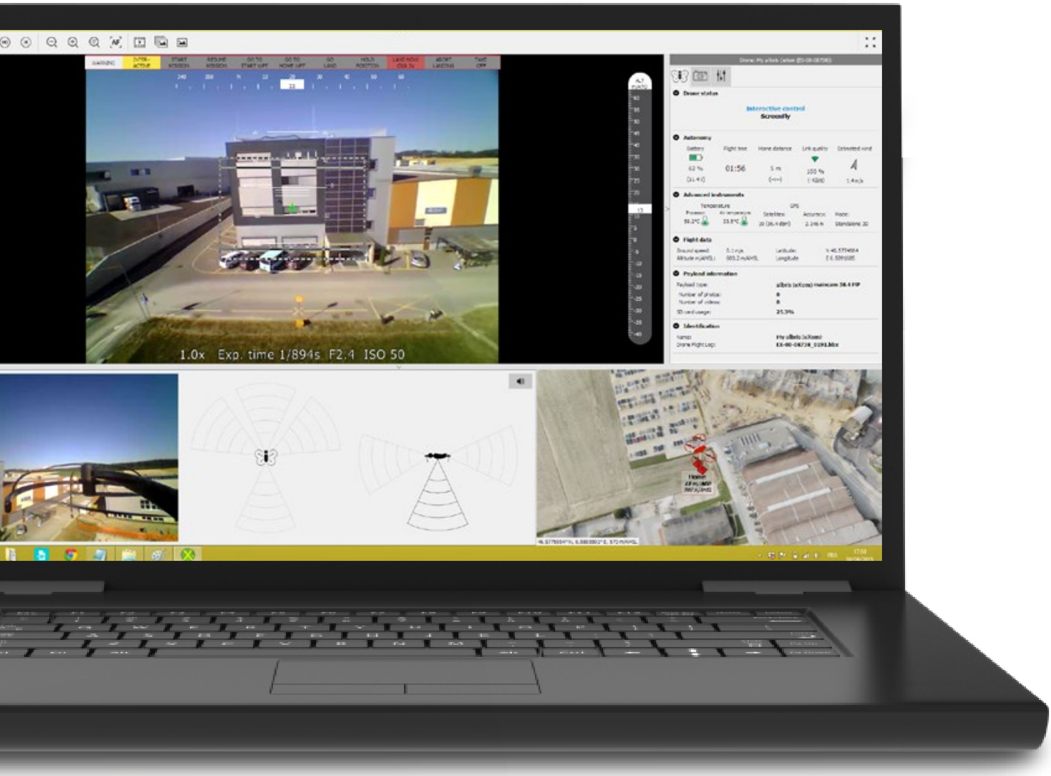
Navigate, check for obstacles, see side views

Bottom

Navigate, check for obstacles, land autonomously

Rear

Navigate, check for obstacles, reverse safely


1.0x Exp. time 1/894s F2.4 ISO 50


senseFly

Choose the flight mode that suits your project

Fully autonomous

Are you looking to map a small site, such as a plant or construction site, directly from above? Or maybe a specific point of interest such as a building or tower? If so, choose an autonomous albris mission.

- Specify your area/point of interest in the drone's supplied eMotion X software
- eMotion X generates a GPS waypoint-based flight plan
- The albris takes off, flies, acquires imagery & lands itself
- View albris' live video stream during flight
- Record imagery on albris' SD card as required for post-flight analysis
- Use image processing software to generate 2D maps & 3D models

Suits: High-res 2D mapping, 3D building mapping, construction monitoring, agricultural & archaeological mapping.

Interactive ScreenFly mode

Need to perform a live inspection? Use the drone's supplied ScreenFly controller to fly an assisted interactive mission.

- Take-off in interactive mode (or switch into this during an autonomous flight)
- 'See what albris sees' on-screen via its multiple live video feeds
- Anti-Drift, Cruise Control & Distance Lock
- Centre albris' cameras on a target
- Capture high-res still images on demand
- GNSS Off option to fly in GNSS-deprived enviroments

Suits: Structural inspection & documentation, crack/defect detection, solar panel analysis, tower inspection etc.

Live feedback
See what albris sees via its wide-angle navcams

Instant operation
The senseFly albris is ready to fly straight out of its supplied carry case – no construction required

Safety smart
Numerous self-monitoring & automated failsafe procedures reduce the risk of inflight issues, minimising potential danger to structures, people & the albris airframe

Close-object operation
Advanced situational awareness and flight stabilisation are enabled by the drone's:
· 5 ultrasonic sensors
· 5 navcams (visual sensors)

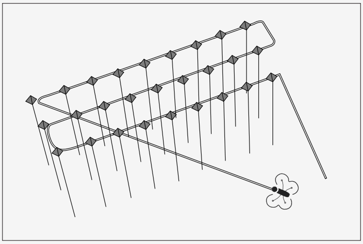
Onboard albris

The senseFly albris is lightweight, shock-absorbent and durable, designed to operate in tight working environments. With its forward-positioned TripleView camera head and open-fronted airframe it offers an unrivalled field of view, while its propellers are fully protected by its advanced carbon fibre shrouding.

Bump-safe construction
The senseFly albris' shock-absorbent carbon fibre shrouding protects the drone in case of low-speed surface contact

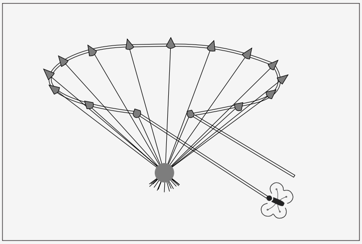
Electric powered
Low noise, no pollution, and easy battery swapping for prolonged use

Leading autopilot technology
The artificial intelligence built into the senseFly autopilot analyses a raft of data to optimise every aspect of your flight



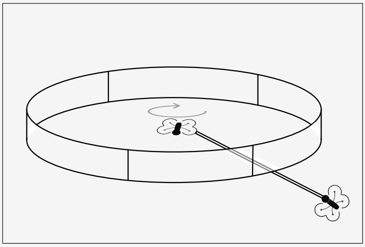
Horizontal Mapping

Use this mission block to fly a 'bird's eye', top-down mapping mission (senseFly eBee style). Just set a few key mission parameters, such as your preferred ground resolution, and eMotion X does the rest — creating flight lines and setting GPS waypoints, which are adapted to the terrain, automatically.



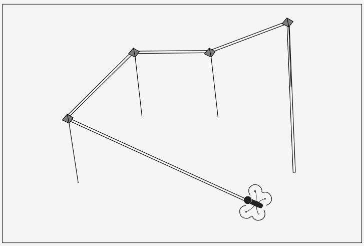
Around Point of Interest

This mission block automatically centres the drone's flight path around a specific point of interest. Once you've set the resolution/distance required, eMotion X automatically programs the image capture points. Use this mission block to create a 3D model of an object.



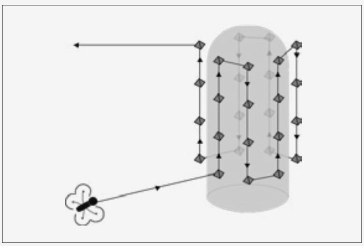
Panorama

This mission block suits a wide range of applications. You could fly a panoramic mission to gain an initial overview of a concave location, such as the curved cliff face of an open pit mine, to give that wow effect to reporting and documentation, to enhance the quality of 3D models... the choice is yours!



Custom Route

This mission block is perfect for guiding the drone through complex environments. Or if you want to use different types of mission block during a single flight, you can link these together using custom routes.



Cylinder

Inspect & digitally model structures such as wind turbines and towers using a senseFly albris. Just set the cylinder's height, its height above ground, plus the image resolution & overlap required. eMotion 3 sets the drone parameters and waypoints required to capture exactly the photos required—in overlapping layers—around the structure.

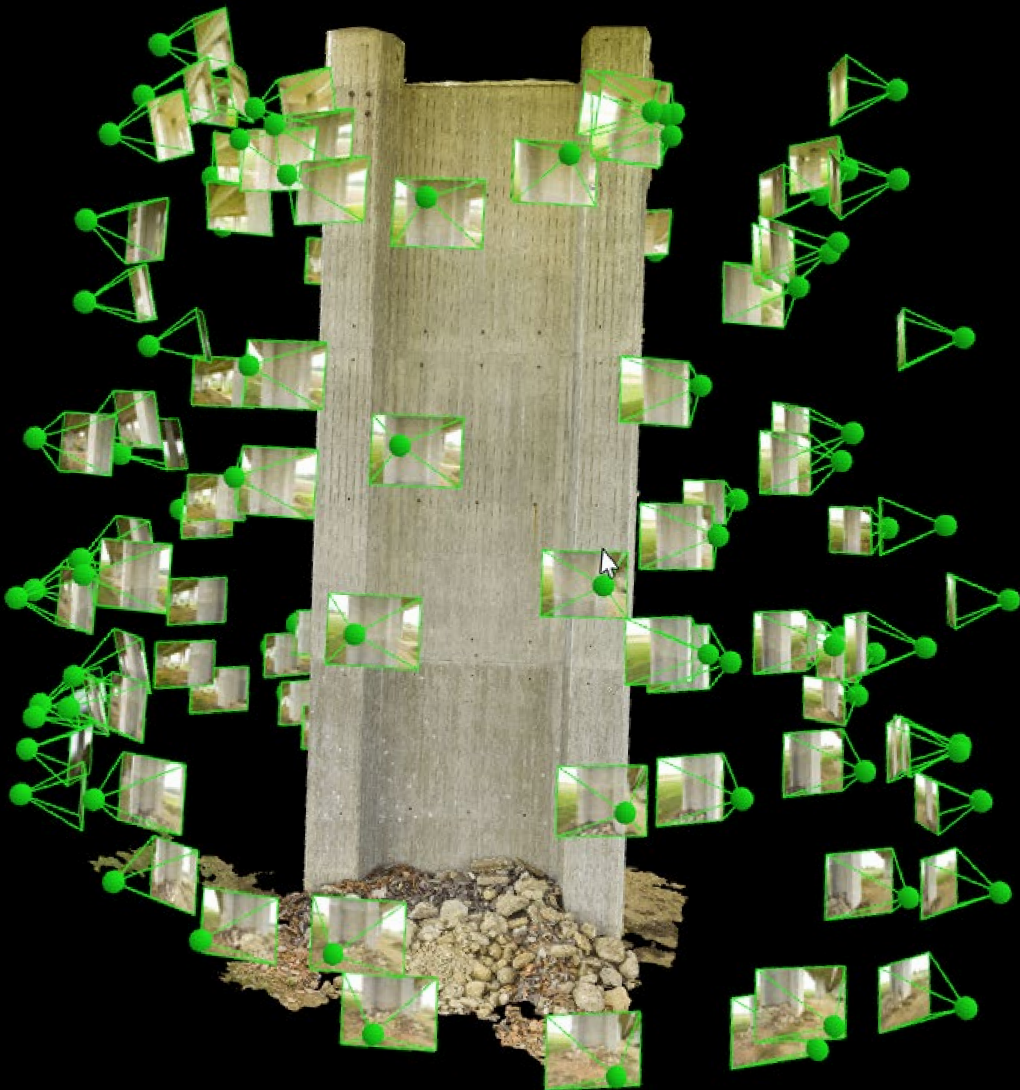
Intuitive flight planning & feedback

Every senseFly albris is supplied with eMotion X software, senseFly's proprietary flight planning, control and feedback program. Developed specifically for albris, eMotion X is your flight control centre — featuring live streaming video feedback, full control of what imagery albris captures, access to sensor and flight data, plus full flight planning functionality.

Choose your mission block

Flight planning in eMotion X is simple: just select the pre-programmed mission block that best suits your project. Further advanced mission blocks and software updates will be available for free.

* Accessible via my.senseFly at no extra cost.



Road bridge pillar inspection, Switzerland

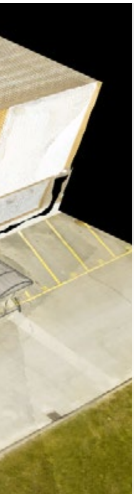
Create geo-referenced maps & models

After albris lands, simply use eMotion X's built-in Flight Data Manager to pre-process, geotag and organise its images, before starting image processing.

Then use professional image processing software to transform the drone's images into geo-referenced 2D orthomosaics, 3D building models, 3D point clouds, triangle models, digital surface models and more.

High-resolution mapping

Create high-resolution 2D and 3D maps, or complement fixed-wing drone data by mapping a site's highly inclined and vertical surfaces



3D modelling

Capture high-resolution aerial imagery and transform this into full 3D models of buildings and small/medium-sized infrastructure

Inspection

Examine and document surfaces and objects—such as bridges, towers, rooftops and cliff faces—in high-resolution

Plus…

- Crack detection
- Bridge, pipe & tower inspection
- Plant inspection & documentation
- Stockpile assessment
- Construction monitoring
- Close agricultural & archaeological mapping
- Solar panel hotspot detection
- Conservation & environmental monitoring

… and much more

Flight modes

Types	Automatic Interactive ScreenFly Manual (RC)
Availability	Switch between modes at any time

Automatic

Control interface	Mouse, keyboard or touchscreen
Mission planning	Drag-and-drop mission blocks
Types of mission blocks	Horizontal mapping Around point of interest Panorama Custom route
In-flight mission changes	Yes: manual waypoint changes and updates possible at any time

Interactive ScreenFly

Primary control interface	Screen-based actions & USB controller
Flight assistance (depending on the flight phase)	Cruise control Distance lock Range sensing

Manual (RC)

Primary control interface	RC (remote control)

On-board computing

Type	4 on-board CPUs
Quad-core processor	Principal autopilot & artificial intelligence
Dual-core processor	Video co-processing
Single-core processor	Low-level autopilot (safety fallback) and motor control
Single-core processor	Communication link management

Flight system

Type	V-shaped quadcopter
Dimensions (incl. shrouding)	56 x 80 x 17 cm (22 x 32 x 7 in)
Engines	4 electric brushless motors
Propellers	4
Take-off weight	1.8 kg (3.9 lb) incl. battery, payload & shrouding
Flight time (full system)	Up to 22 min
Max. climb rate	7 m/s (15 mph)
Max. airspeed	Automatic flight: 8 m/s (18 mph) Manual flight:12 m/s (27 mph)
Wind resistance	Automatic: up to 8 m/s (18 mph) Manual: up to 10 m/s (22 mph)
Autopilot & control	IMU, magnetometer, barometer & GPS/GNSS
Materials	Composite body, moulded carbon fibre arms and legs, precision-molded magnesium frame, precision-molded injected plastic
Operating temperature	-10 to 40º C (14º-104º F)

Wireless communication

Main communication link

Type	Digital, dual omnidirectional antennas, dual band, encrypted
Frequency	2.4 GHz & 5 GHz ISM bands (country dependent)
Data transmitted	Commands, main camera stream, navcam stream, sensor data, etc.
Range	Up to 2 km (1.2 mi)

RC (Remote control)

Type	Digital
Frequency	2.4 GHz
Range	Up to 800 m (0.5 mi)

System power

Technology	Smart battery
Type	LiPo, 3 cell, 8500 mAh
Power level display	LED display on battery, on-screen information
Charging time	1 - 1.5 h

Integrated payloads

TripleView head

Main camera

Still images	38 MP, mechanical shutter DNG (RAW image with correction metadata) Ground sampling distance (GSD): - 1 mm/pixel at 6 m - 1 cm/pixel at 60 m Recorded on board Geo-referenced (position & orientation)
Video	HD (1280 x 720 pixels) Recorded on board or streamed
Horizontal field of view	63 degrees
Digital zoom	6x

Thermal camera

Still images/video	Thermal (80 x 60 pixels) overlaid on main camera stream
Horizontal field of view	50 degrees
Edge enhancement	Yes

Head navcam (visual sensor)

Video	VGA (640 x 480 pixels)
Video live streaming range	Up to 2 km (1.24 miles)
Horizontal field of view	100 degrees

Lights

Headlamp	Yes, used for video
Flash	Yes

Additional navcams (visual sensors)

Number	4 navcams
Positions	Left, right, rear, bottom
Video	VGA (640 x 480 pixels)
Horizontal field of view	100 degrees
Availability	One navcam at a time
Operational use	Side views (w/o turning main camera) & parallel flight along objects Back-up safely & control in tight environments Landing & ground proximity

Situational awareness & assistance

Multidirectional video feed

Source	Navcams (visual sensor)
Number	5
Video	VGA (640 x 480 pixels)
Horizontal field of view	100 degrees
Availability	One navcam at a time

Object & range detection

Sensor	Ultrasonic
Number	5
Range	Up to 6 m (20 ft)
Feedback	Audio and visual object warning

Operational safety

Shrouding

Material	Carbon fibre
Function	Defines propeller rotation area Protects from damage at low speed

Signalisation lights

Navigation lights	2 green on the right, 2 red on the left
Anti-collision lights	1 top strobe, 1 bottom strobe

Ground proximity detection

Avoidance procedure	Automatic stop (can be deactivated)
Warning signals	Audio & visual

Flight assistance features (Interactive mode)

Cruise control	Maintains (low) constant speed in a given direction
Distance lock	Keeps distance to frontal objects 3 - 5 m (9.8 – 16 ft)
Obstacle avoidance	Depending on flight phase

Safety procedures

Automated failsafe behaviours	Geofencing, return home, emergency stop, emergency landing
Operator triggered	Hold position, return home, go land, land now, emergency motor cut-off

Autopilot fallback

Type	Independent low-level autopilot (backup for main autopilot)
Manual RC control	Independent RC controller (take manual control at any time)

Ground station software

Software application	senseFly eMotion X (supplied)
Mission planning	Intuitive 3D user interface Click and drag to set mission blocks Automatic 3D flight planning Edit mission plans during flight
Flying	Automated system checks Automated take-off & landing Real-time flight status Main camera video feed integration Thermal video feed integration Navcam video feed integration Fully automatic flight Interactive ScreenFly Manual flight (with assistance functions) In-flight switch between flight modes Black-box recording of all flight & mission parameters
After your flight	Project & data management DNG to JPEG conversion

Package contents

- 1 senseFly albris drone
- 1 Interactive ScreenFly controller
- 2.4 GHz remote control (for safety pilots)
- 2.4 GHz/5GHz dual band USB radio modem
- 2 SD memory cards (32 GB)
- 2 batteries
- 2 single battery chargers w/power supplies
- 1 wheeled carry case
- 1 user manual
- 1 USB cable set
- 1 spare leg set
- 1 spare propeller set
- eMotion X flight planning & control software

www.sensefly.com

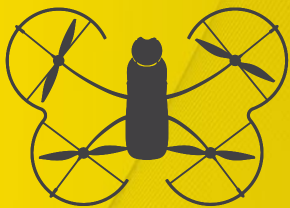
About senseFly: At senseFly, we believe in using technology to make work safer and more efficient. Our proven drone solutions simplify the collection and analysis of geospatial data, allowing professionals in surveying, agriculture, engineering and humanitarian aid to make better decisions, faster.

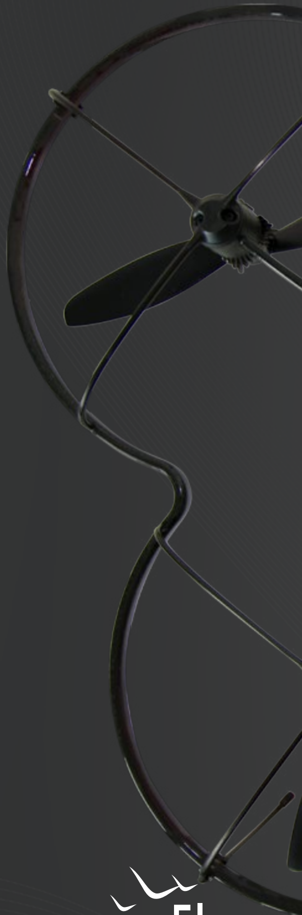
senseFly was founded in 2009 and quickly became the leader in mapping drones. The company is a commercial drone subsidiary of Parrot Group. For more information, go to www.sensefly.com.

How to order your albris? Visit www.sensefly.com/about/where-to-buy to locate your nearest distributor.

senseFly Ltd
Route de Genève 38
1033 Cheseaux-Lausanne
Switzerland

www.sensefly.com/albris
Swiss made

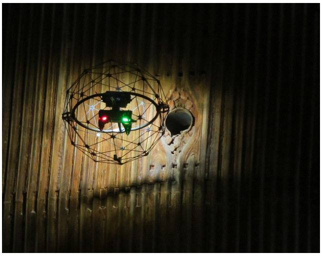




senseFly
a Parrot company

For albris updates
subscribe to our newsletter at
www.sensefly.com


ELIOS
INSPECT & EXPLORE INDOOR SPACES
THE COLLISION-TOLERANT UAV DESIGNED FOR INDUSTRIAL INSPECTION PROFESSIONALS
ACCESS CONFINED & COMPLEX SPACES
OPERATE EASILY WITHOUT RISK TO WORKERS
REDUCE DOWNTIMES & CUT INSPECTION COSTS
FLYABILITY
SAFE DRONES
FOR INACCESSIBLE PLACES
WWW.FLYABILITY.COM



LOWER COSTS, HIGHER SAFETY

Decrease downtime and inspection costs, avoid confined space entry and increase worker safety by remotely accessing boilers, tanks, pressure vessels, tunnels and other complex environments inside your plant.

EASY TO PILOT, INSTANT OPERATION, ANYWHERE

No piloting experience needed. Simply unpack, insert the battery and fly without risk of collision, damage or injury. The drone is capable of taking off and landing in any variety of environments.

ALL-IN-ONE SOLUTION FOR HIGH RESOLUTION IMAGERY

Elios is capable of delivering images up to 0.2 mm/px, even in complete darkness. Along with its LED lighting and thermal imagery, it inspects and explores the unreachable.

CONTACT US FOR YOUR QUESTIONS OR TO GET A QUOTE

INTEGRATED PAYLOAD

Simultaneous full HD and thermal imagery recording, and adjustable tilt angle.

ON BOARD LIGHTING

Powerful LEDs for navigation and inspection in dark places.

CONTINUOUS OPERATION

Batteries can be changed in seconds.

LIVE 2.4 GHZ VIDEO FEEDBACK

Robust digital video downlink for beyond line of sight operation, even in metallic environments.

PROTECTIVE FRAME

Carbon fiber structure, collision-tolerant up to 15 km/h. Modular design for easy maintenance.

POST-MISSION REVIEW

Post-mission review on our ground software for an easy access to the acquired data.

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Lausanne, Switzerland

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sales@flyability.com

FOLLOW US

@fly_ability
Flyability-Gimball
Flyability
Flyability

APPENDIX C: BEST PRACTICES AND SAFETY GUIDELINES

TABLE OF CONTENTS

FEBRUARY 2017 UNMANNED AIRCRAFT SYSTEMS (UAS) BEST PRACTICES

H.1 *OVERVIEW*

An Unmanned Aircraft System (UAS) is defined by the Federal Aviation Administration (FAA) as an aircraft operated without the possibility of direct human intervention from within the aircraft. Unmanned aircraft are commonly referred to as drones, and the names can be used interchangeably. The use of UASs to aid in bridge inspection should be considered as a tool to a qualified Team Leader when a hands-on inspection is not required. UASs are controlled either autonomously or with the use of a remote control by a pilot from the ground. Current technologies for commercial use include both fixed wing and rotor aircraft, although for bridge safety inspections rotor aircrafts are more suitable. A wide range of imaging technologies including still, video, and infrared sensors can be obtained aerially. On-site or in-office image processing can then be used to facilitate inspection data collection. UASs themselves cannot perform inspections independently but can be used as a tool for bridge inspectors to view and assess bridge element conditions in accordance with the National Bridge Inspection Standards.

This chapter is not intended to be a training manual on the use of UAS for bridge inspection and only provides the minimum requirements necessary for Federal and State compliance . The owner or engineer may have to implement additional requirements that exceed those outlined in this chapter based on specific site conditions and engineering judgment or when presented with unusual circumstances.

H.2 ABBREVIATIONS

AMSL – Above Mean Sea Level

ATO – Above Take Off

ATC – Air Traffic Control

BLOS – Beyond Line of Sight

PIC – Pilot in Command

UAS – Unmanned Aircraft System

FAA – Federal Aviation Administration

H.3 UAS OPERATIONS

The following sections describe the recommended operating procedures and considerations when using UAS for bridge inspections.

H.3.1 FEDERAL REGULATIONS

The Federal Aviation Administration (FAA) of the United States is a national authority with powers to regulate all aspects of civil aviation. These include the use of UAS for commercial purposes. All bridge inspections that utilize UAS are required to follow the FAA's UAS requirements.

UAS operations are allowed with a Certificate of Waiver or Authorization (COA) or under the FAA's new policies. The new policies are referred to as Small Unmanned Aircraft Regulations (Part 107). These new regulations are intended to establish more general and basic guidelines for commercial entities and the general public. The new legal guidelines apply to drones weighing less than 55 pounds, operated within the visual line of sight of the remote pilot in command, and flown during daylight hours. The remote pilot in command must have a Remote Pilot Certification from the FAA which can be obtained by passing an aeronautical knowledge test. With direct supervision from a licensed remote pilot, anyone over the age of 16 can legally operate a drone for commercial purposes. Each UAS must be registered with the FAA. Operations in Class G airspace are allowed without air traffic control permission (ATC), however operations in Class B, C, D and E airspace need air traffic control approval. A basic summary of the requirements are included below.

Pilot Requirements	Must have Remote Pilot Airman Certificate Must be 16 years old Must pass TSA vetting
Aircraft Requirements	Must be less than 55 lbs. Must be registered if over 0.55 lbs. (online) Must undergo pre-flight check to ensure UAS is in condition for safe operation
Location Requirements	Class G airspace Classes B, C, D, and E airspace can be flown with an FAA waiver
Operating Rules	Must keep the aircraft in sight (visual line-of-sight) Must fly under 400 feet Must fly during the day Must fly at or below 100 mph Must yield right of way to manned aircraft Must NOT fly over people Must NOT fly from a moving vehicle
Legal or Regulatory Basis	Title 14 of the Code of Federal Regulation (14 CFR) Part 107

More information on Part 107 can be found on the FAA website.
https://www.faa.gov/uas/getting_started/fly_for_work_business/

H.3.2 MnDOT REQUIREMENTS

The offices of Aeronautics and Chief Counsel provide assistance to districts and offices that are pursuing or contracting for UAS services. The Aeronautics Office has an official policy for the use of UAS on MnDOT projects. The policy is detailed at the following website:
http://www.dot.state.mn.us/policy/operations/op006.html

For UAS operation, MnDOT employees must:

Obtain a blanket public Certificate of Waiver or Authorization (COA) that permits flights in Class G airspace at or below 400 feet, or

Perform operations that adhere to 14 CFR Part 107 ("Part 107" operations).
Use without adhering to the federal regulations can result in fines and other legal penalties.

When contracting for UAS services, the contractor must adhere to the requirements of Part 107. MnDOT will review Section 333 Exemption and COA of third parties, and these contractors will be required to license the vehicle and obtain a commercial operator's license from the MnDOT Office of Aeronautics as required by Minnesota Statutes §360.521 - Minnesota Statutes §360.675.

H.3.3 EQUIPMENT

UAS equipment is available that is specific to inspections with features that are important when performing bridge inspections. Consumer level drones can provide some benefits but generally don't have many of the features required for a bridge inspection. It is recommended to employ a UAS specifically designed for commercial inspection and mapping purposes. While technologies and capabilities differ, the most common inspection specific UASs share these general features:

- Powered by rechargeable batteries
- Controlled either autonomously or with a remote control device
- Contain 4 to 8 rotors
- Ability to use GPS to track location
- Contain fail safes such as return to home technology
- Includes a camera with both video and still image capabilities
- Thermal sensors
- Proximity sensors and awareness
- Ability to preprogram autonomous missions
- Ability to fly under bridge decks in a GPS denied environment and within confined spaces.
- Ability to look straight up to view the underside of a bridge deck

Any UAS used should have a preflight inspection performed to ensure the equipment is operating properly. Special attention should be paid to critical parts including propellers and should be replaced according to manufacturer recommendations.

H.3.4 SAFETY

While UASs have proven to reduce risks associated with bridge inspections, safety remains a top priority. UAS operations are not without risk, especially when operating near the public, but a well thought out safety plan will minimize and mitigate those risks.

H.3.4.1 Inspection Team Qualifications

The UAS operator is required by the FAA to have a Remote Pilot Certification. In addition, the operator should be very familiar with the UAS and have studied the owner's manual and received training on the operation of the UAS before attempting to fly near a bridge. Similar to manned aircraft, the crew should not operate with a medical condition that could interfere with safety. Generally, the minimum size of a crew should be two people, one to operate the aircraft and one to act as a spotter. It is recommended that the operator also be a qualified bridge inspector and at a minimum, the bridge inspector should be on site at all times directing the inspection.

H.3.4.2 Site Safety

A safety plan should be prepared that addresses site safety and the proper qualifications of personnel and proper use of the UAS. The safety plan should address the following:

- Purpose of the effort
- Field team personnel
- Site location
- Structure description
- Any site specific hazards
- FAA airspace class and waiver status if required
- Any privacy concerns

All personnel should be equipped with full personal protective equipment including eye protection and hard hats. The operations area should be delineated with cones, signs, and markers. If operations include the possibility of drivers seeing the drone within close proximity, Drone Inspection Ahead signage should be placed so drivers are not distracted by a UAS sighting. An onsite safety briefing should be performed before work begins on the site each day.

H.3.5 PRIVACY

Most bridge inspections are performed in areas where the public does not have a reasonable expectation of privacy. However the following practices are recommended as a way of ensuring as much privacy as reasonably possible for the public.

- If you can, let others know you will be taking pictures or video of them before you do.
- If someone asks you to delete personal data about him or her that you have gathered, do so.
- Do not fly over other people's private property without permission if you can easily avoid doing so.